

computing today

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OCT 1979

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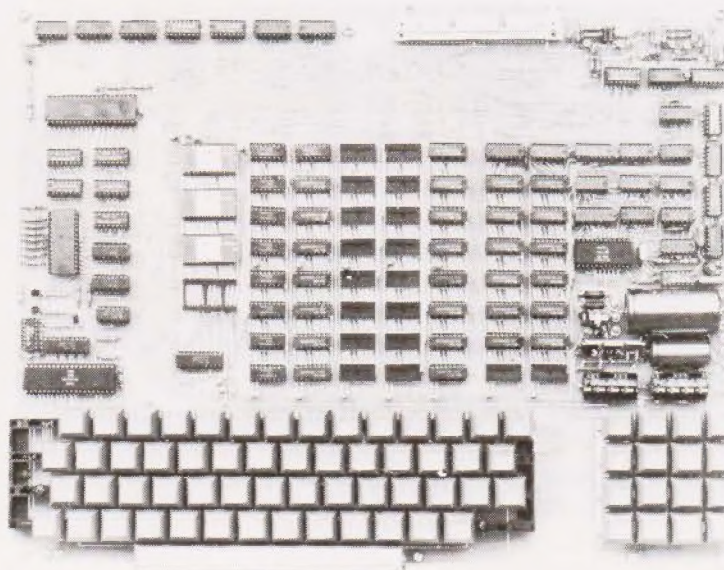
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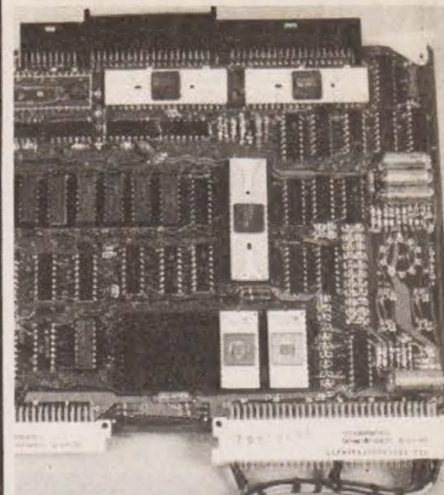
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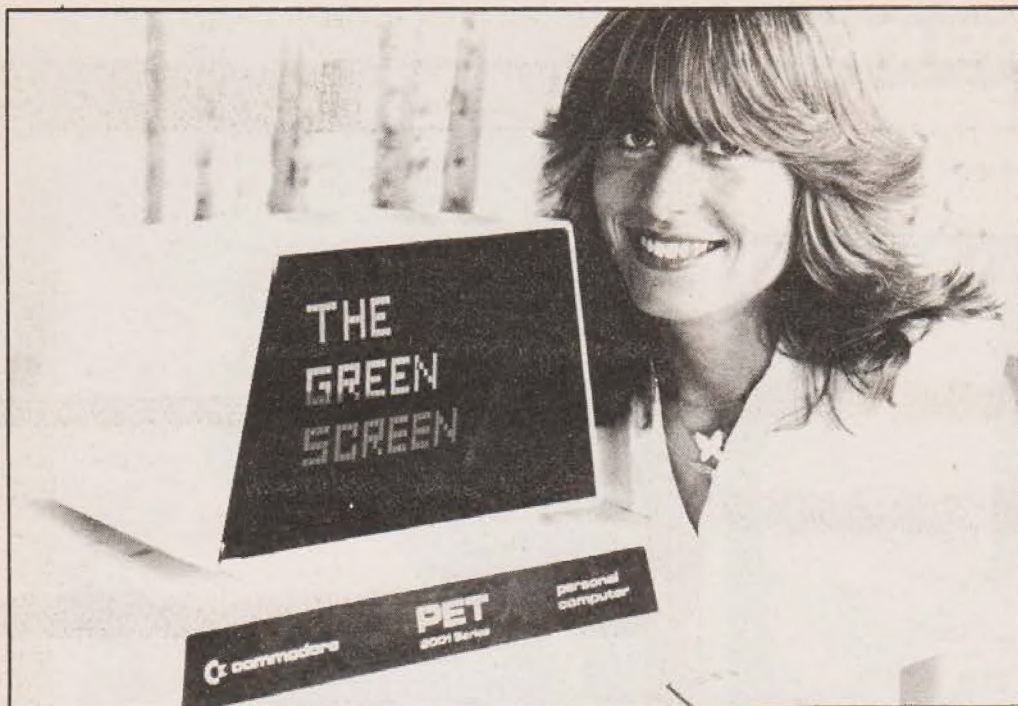
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GREEN IS BEAUTIFUL

Available now from Petsoft is an instant green screen device. Using a special optical perspex it will attach to the front of any standard PET and relieve eyestrain as well as cutting down on ambient light reflection. For a mere £8.50 plus VAT you can get one from your local dealer or direct from Petsoft at 5 Vicarage Road, Edgbaston, Birmingham B15 3ES.

COLOUR NASCOM

Adding colour graphics to a Nascom is now easy with a Micrographics kit from William Stuart. Using a true dot generator rather than preformed characters the system gives control over the whole screen by using supplied subroutines. All program code is relocateable and compatible with any Nascom monitor. As well as allowing eight colours to be used in the graphics a choice of eight background colours are available and text can be mixed with diagrams. Text colours can be changed in two instructions. The kit is supplied complete with a PAL modulator and documentation. A demo program is supplied as well to show what can be done. Cost is £45 for the kit or £59 assembled and it can be obtained from William Stuart Systems Ltd., Dower House, Herongate, Brentwood, Essex. CM13 3SD.

NEWBEAR EXPAND

The Newbear computing store has recently added dealerships for the Apple and Ithaca International to its collection. The decision to opt for Apple rather than the ITT2020 was taken after discussions held at the NCC and they can now supply the 16K Eurapple at £830 plus VAT. From Ithaca comes the DPS-1 system, an S100 based system with front panel, back-

plane and power supply. Up to 20 user boards can be held and a full range is available. More

details on both new dealerships can be had from Newbear on 0635-30505.

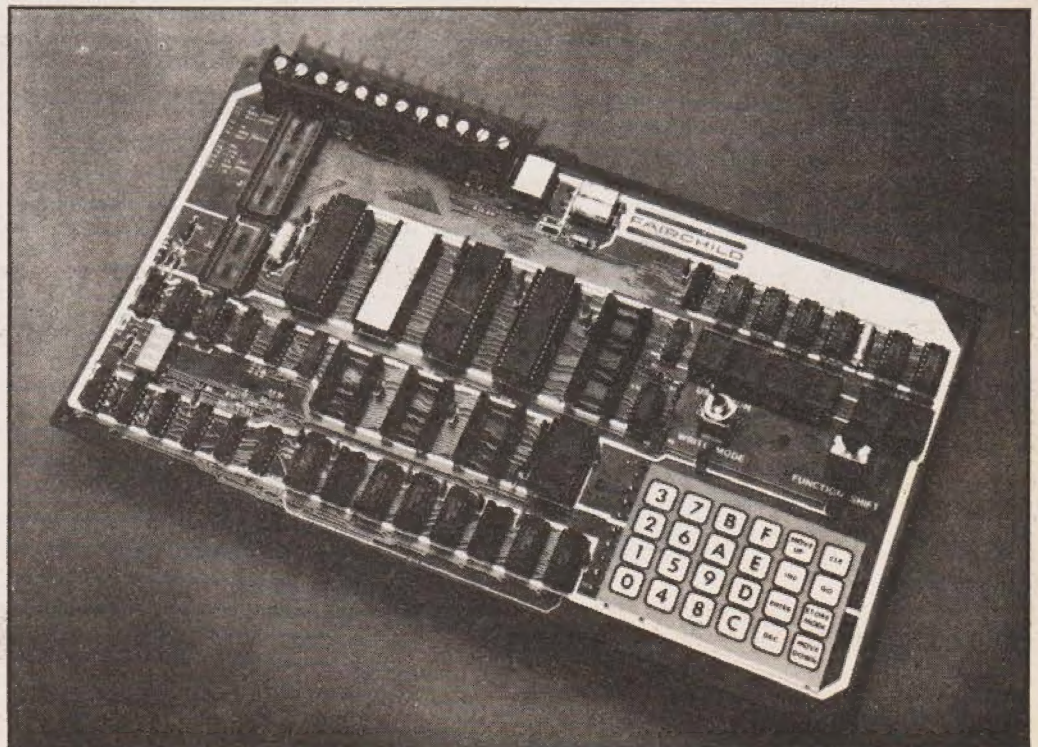
BOOK SELL OUT

The National Computing Centre's book called *Introducing Microprocessors* has gone into reprint already — it was only launched in June. This is

one of the 18 new titles being published and the free catalogue is available from the NCC at Oxford Road, Manchester, M1 7ED. Over 90 books are available covering a wide range of subjects from standards to applications.

PEP SYSTEM FROM FAIRCHILD

A single board evaluator has been recently introduced by Fairchild for the F387X family of 8 bit micros. The PEP system allows a user to write and debug programs and hardware for the chip series and also allows in circuit emulation via an umbilical. Programs can be called down from a cross assembler on a development system such as the Intel MDS or the Formulator. On board facilities include a keypad and a six digit LED display. Also available is an RS232 Port at 110 to 1200 Baud for connection to a full terminal. 2K of 2114 static RAM is available, expandable to 4K as well as a separate 128 byte workspace. You can also blow 2716 EPROMS from the board and there is space for up to 6K of these devices on board. The monitor is a 2K firmware type and other features include crystal controlled clocks, four programmable timers and four general purpose interrupt controls. Contact Fairchild at 230 High Street, Potters Bar, Herts EN6 5BU.



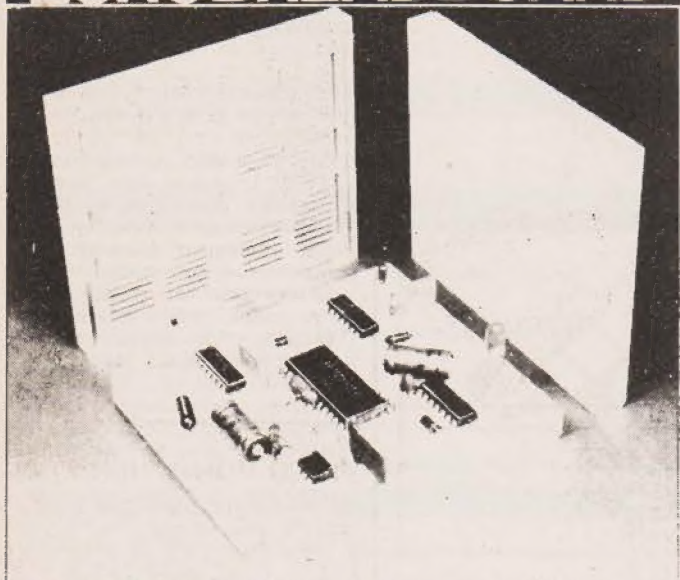
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LITTLE FINGERS?

A new range of miniature keyboards is being imported by Walmore Electronics. The Apex range of microkeyboards are full 8 bit ASCII and about 1/3rd the size of a conventional keyboard. Designed mainly for portable and instrumentation

equipment and are fully TTL/MOS compatible. All switches have a tactile "feel" and there are selectable parity and strobe/data inversion facilities. For those of you with little fingers please contact Walmore Electronics Ltd., Displays Division, 11-15 Betterton Street, Drury Lane, London WC2H 9BS.

CLUB FORUM

Some more connections have reached me on the Club Survey this month. Apparently the Eltham ACC and the South East London Micro-computer Club are one and the same and the latter name is now the correct one, or SELMIC for short. They now have around 150 members and a new committee. Primary contacts are Treasurer, Mr Hugh Gillespie on 01-303 4968; Membership secretary, Mr Malcolm Beresford on 01-698 1422 and the Chairman, Mr John Williamson on 01-850 4195.

The latest schedule has reached me from the East London Amateur Computer Club. They have demos scheduled for Apple on the 16th of October and the

AGM on the 20th of November, among others. They meet on the third Tuesday of each month at Harrow Green Library in Cathall Road, Leytonstone from 7pm to 10pm. Bus routes 10 and 262 and Leyton tube are most convenient transport. An informal meet is held on the first Tuesday of each month in The Bell pub, Leytonstone High Road. A book loan scheme is being set up within the club, a newsletter is published and membership is currently £2.50 (half price for students). For more details contact the Chairman, Jim Turner at 63 Millais Road, London E11.

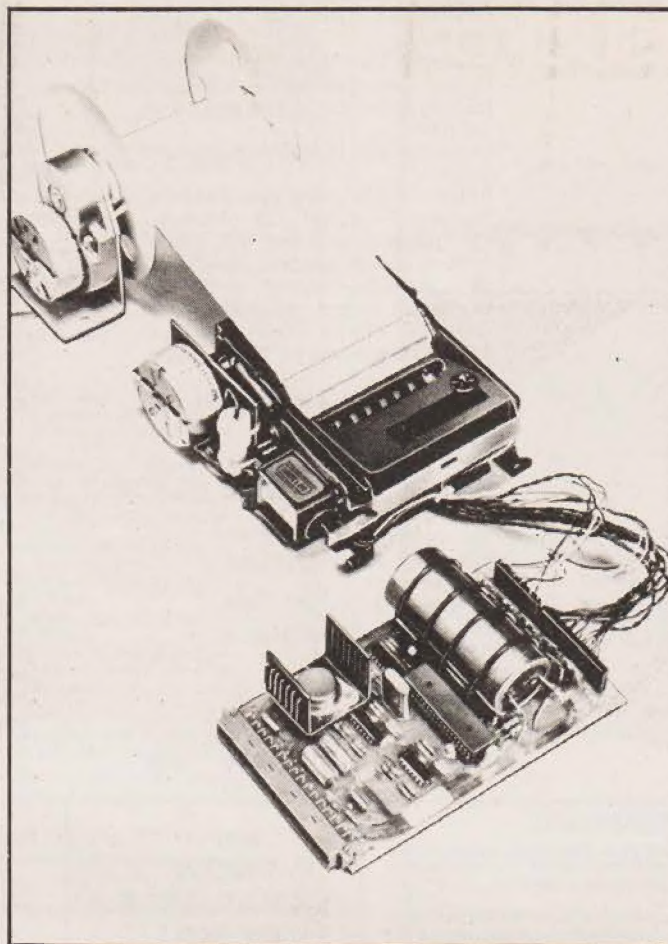
Next on the list is the Brunel Technical College Computing Club. They now have an elected committee of 7 and 42 mem-

PRINTA PRINTER

A range of OEM printers is available from Landis and Gyr of North London. All of the Sodeco range in either 15 or 20 column widths can be supplied in text or data formats and a two control cards are available for connection to either an ASCII data source or a BCD source. Both interface cards are on a Eurocard format and require +24V unstabilized. A buffer store can be included to hold one line whilst one is printing. Also available is a winder unit to take up the roll print. Further details from Landis and Gyr, Industrial Components Division, FREEPOST, London W3 6BR or ring 01-992 5311.

STARBASE BASIC

Starbase, have produced an 8K BASIC for the Nascom. The language is a modification of the Microsoft standard package and locates at 1000 to 2FFFF and will work in any system with an additional 16K. All variables are copied into a workspace area so the language may be PROM blown with no mods. All current monitors are supported and line editing will be available with Nas-Sys. Extra features of the language are a WIDTH command and a facility to use a standard terminal via the serial interface. The LIST command will scroll a specified number of lines and the Nascom graphics option is also supported. Program Load and Dump uses the T4 routine with checking and file names. The language costs £30 from your local dealer, Nascom or Starbase at Waxhouse Gate, 15 High Street, St. Albans, Hertfordshire



WINNERS LOSE OUT

It has been brought to our attention that a competition currently being run by Comp Computer Components, see this issue, although totally legal leaves them the winners. How so you may ask? Well the Rules state that all the submitted software becomes the property of Compukit and they may publish it as they see fit. Considering the high prices paid for software by companies and magazines it seems to us that the entrants are paying for their own prizes and leaving Compukit with a veritable pile of valuable 'rejects'.

HIGH RES FOR APPLE

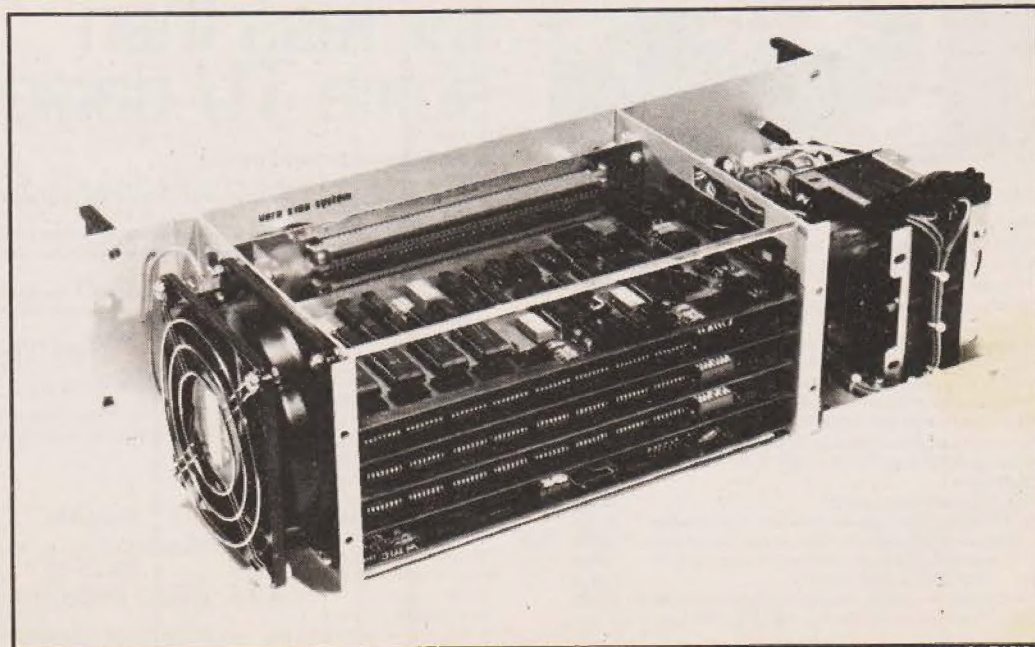
Wanna play with high resolution graphics? Can't afford the terminal! Well you can now simulate the Tektronix 4010 family with your Apple. For about £300 Personal Computers will let you have a TEKSIM ROM chip and adaptor which allows you to display graphics from a host computer, send graphics to the host computer and produce colour graphics. The TEKSIM requires the Apple communication card for connection to the host and then uses software to simulate the Tektronix style graphics on 32 lines of 68 characters. Local commands allow you to save displays on tape or disk. For use as an intelligent graphics terminal the Apple offers a low cost alternative to the Tektronix range with the addition of TEKSIM. For more details contact Personal Computers on 01-623 7970.

HOLD YOUR \$100

Vero have just released an \$100 racking system complete with integral PSU. Capable of handling up to six cards at 4MHz it supplies +8, -8 and +18V and has a fan for cool running. Mains input is filtered and there is a front panel reset control. The unit can either be rack mounted or cased and the sample we saw was of very high quality indeed. A full range of \$100 items is available such as prototype boards and card extenders. For further information contact Vero at the Industrial Estate, Chandlers Ford, Eastleigh, Hants.

bers, the oldest was born in 1902! They meet every third Wednesday and membership costs £2.00. They will be re-starting meetings at the beginning of term and there will be two groups:- skilled and not skilled. Primary contact is Mr S.W. Rabone, 18, Castle Road, Worle, Weston Super Mare, Avon BS22 9JW.

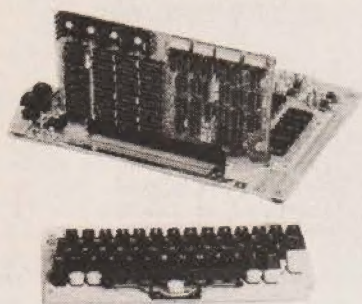
And last but not least this month we have a new club to join our ranks called the Swansea and South Wales Amateur Computer Club the acting committee would like to hear from anyone in the area. Primary contact is Peter Skan, the acting chairman, and you can contact him at 6D7, Vivian House, Roman Bridge Close, Blackpill, Swansea SA3 5BG.



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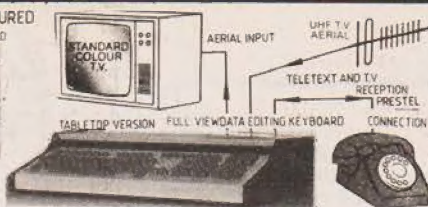
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- *T. Pitman short course on tiny basic manual (nil VAT) **£4.00**
- *RCA 1802 users manual (nil VAT) **£4.00**
- *On cassette Text Editor: Assembler, Disassembler (each) **£16.95**

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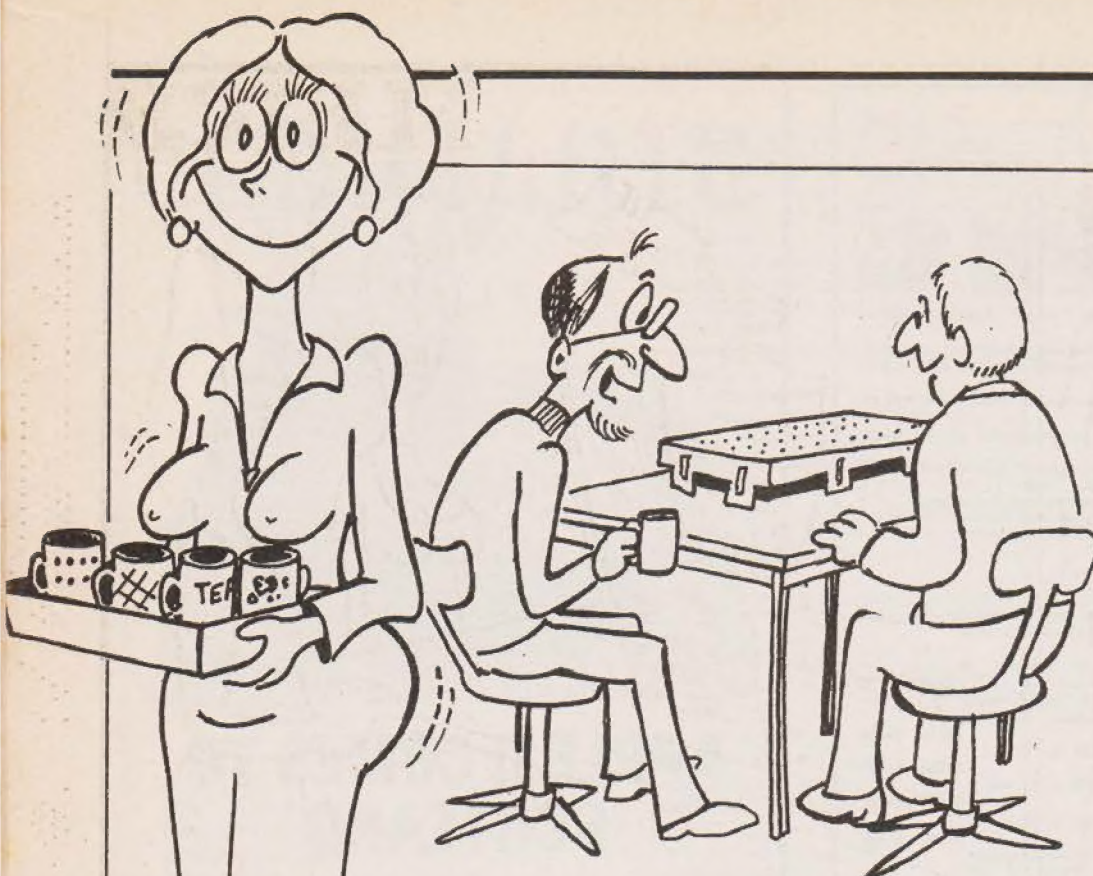
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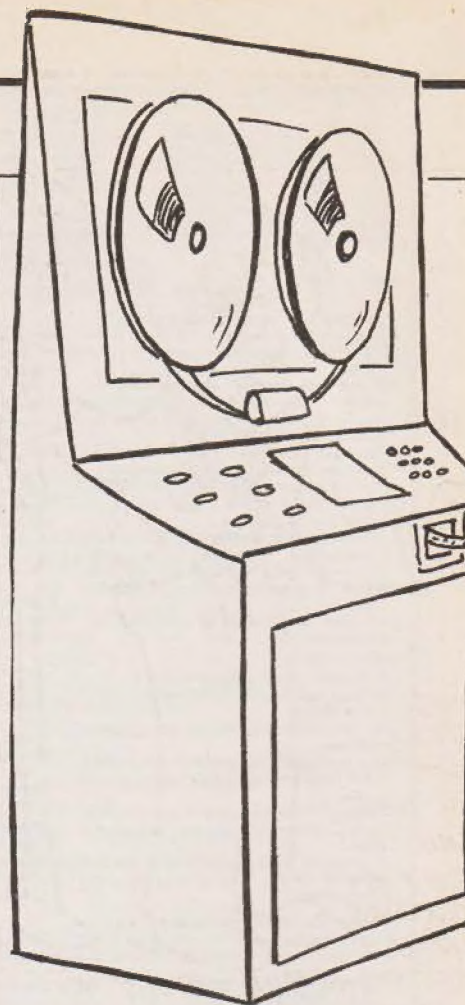
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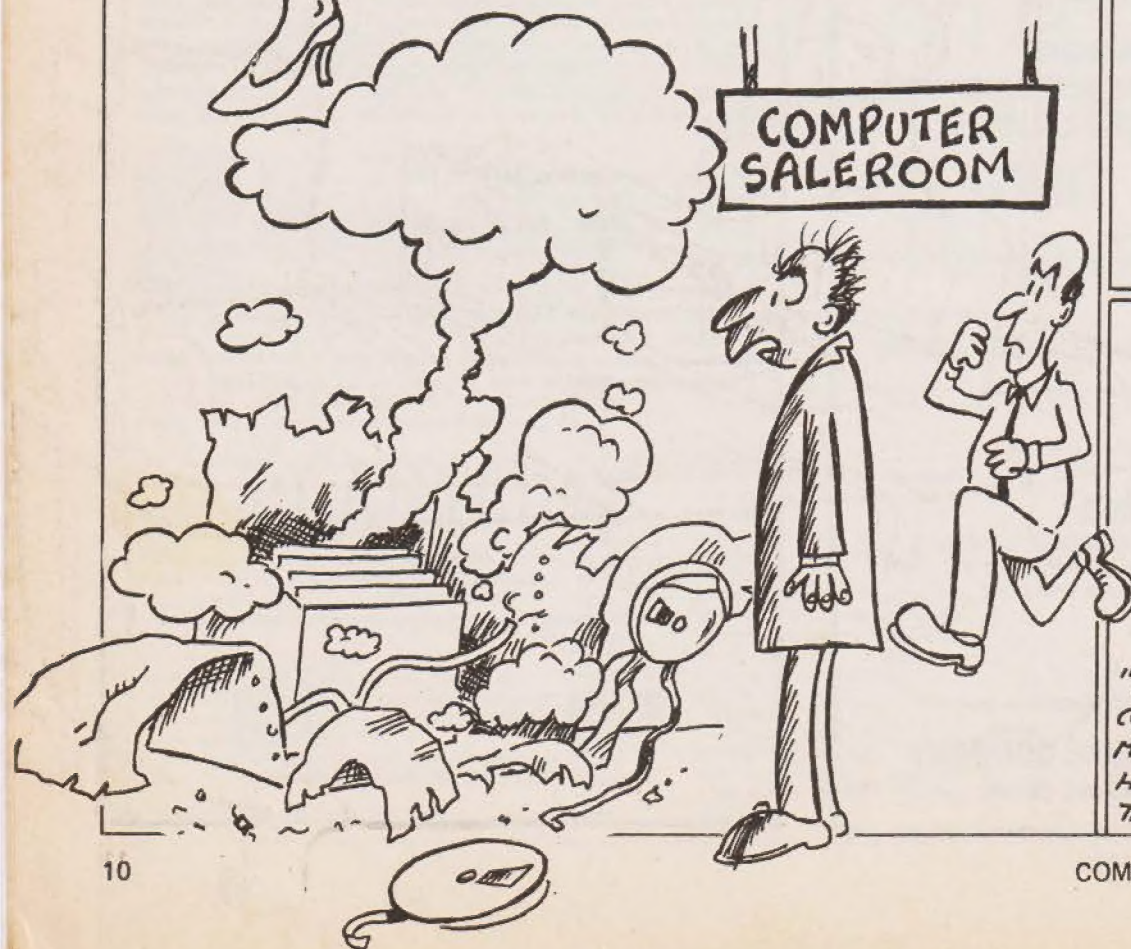


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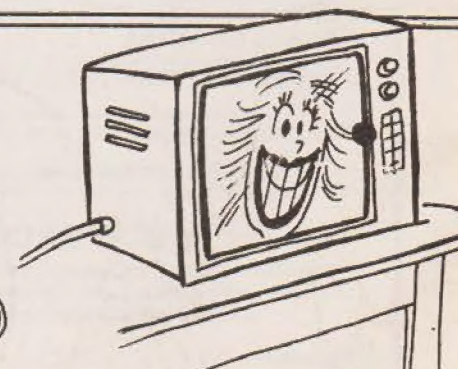


"I MERELY ASKED IT TO
FIGURE OUT ITS OWN V.A.T."

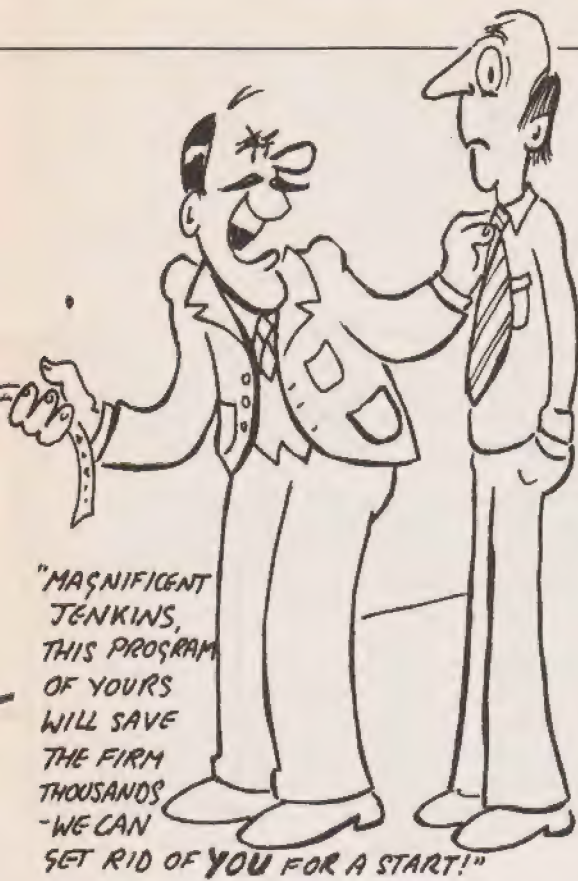
COMPUTER
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"IT'S USELESS OF COURSE
-BUT IT SETS THE CAT
FRUSTRATED AS HELL!"



"MY LATEST INVENTION - A
COMBINATION TV AND
MICROWAVE OVEN. I SET LESS
HALF-BAKED PROGRAMMES
THIS WAY!"



Trevor Lusty introduces the first of a monthly series of BASIC problems

Suppose that someone gives you 1p. It has no effect at all. If you are given a thousand times as much, £10, it is nice but it will do little more than fill your car up with petrol. If you are given a thousand times this amount, £10,000, the situation begins to change. It certainly improves your financial standing, but it does not entirely relieve you of your financial worries. The whole amount can easily be spent on a new car, the deposit on a house, a new computer or just a nice long vacation, and then you are back to worrying about money again. However, if you are given a thousand times more than this, £10,000,000, the basic nature of your situation is changed! Unless you are foolhardy, it is no longer possible to spend all your money on personal expenses. The cost of a suit, a meal, or even a tanker full of petrol becomes meaningless.

Computers have given us a greater change in computation speed than the change in magnitude of the example above. This change has already greatly altered the view of what can be done, and many people believe that we have only just begun to exploit this basic change in the nature of computation. Our goal is to effectively and efficiently harness this computational speed so that our computer can quickly solve some of our problems.

Organizing Problems for the Computer

I have little doubt that you have experienced the difficulty of explaining to a friend how you would tackle an intricate situation or solve a fairly difficult problem. Your explanation would normally comprise of the description of a number of distinct steps, simple enough to be easily understood by someone not familiar with that particular problem. The following is a list of steps which should be checked when trying to solve a problem on the computer.

1. **Find a problem.** This is usually an easy step. My life, like that of most people, is full of problems.
2. **Decide if it is suitable for the computer.** This is by no means as easy. Not all problems are suitable — eg. I fancy the bird in the Computing Today T shirt, but I bet my computer can't help me! Some problems are too trivial and it would take more time to write the program than to solve the problem by hand. A good rule of thumb though is, 'If in doubt — have a go'.
3. **Formulate a precise problem.** This is not as easy as it might seem. Many problems, when examined in detail, turn out to be very different from what they were initially thought to be.
4. **Identify the important variables.** Make idealizations and assumptions about the variables and their relationships. Introduce quantitative measures. (36 — 24 — 36 perhaps) You may well find that your original list of variables is incomplete and have to introduce new ones at a later stage.
5. **Develop an algorithm.** You will need a method for solving your problem. A recipe is a cook's method for solving the problem of how to bake a cake. Remember, however, that your recipe must be suitable for the computer.

6. **Write a program.** If you have been thorough with the two preceding steps, this should not be a difficult task. If your algorithm is formulated as a flowchart, it should be relatively easy.
7. **Test the program.** Compute some results and check these for reasonableness. If they are unreasonable you should re-examine steps 4, 5 and 6 above. You should use simple and varied data for checking purposes. Don't assume that because a program gives the correct results with one set of data that it will do so for all data.
8. **Complete the documentation.** By this stage you should have a rough flowchart and a list of variables with their functions. Tidy up the documentation you already have and insert some comment (REMARK) statements into the program so that a minimum amount of time will be wasted in the future if the program has to be altered for any reason.

The steps given above are not definitive. They are meant as a guide and a 'check-list' to help you to formulate good computer solutions to your problems. It is easy to write simple programs without reference to these steps, but, as you get more ambitious, you will ignore them at your peril.

The Problems

Every month I shall present you with a problem. The following month I shall comment on the problem and give you my solutions. I shall never pretend that my solutions are the only possible ones, I might hope that they are good, but if you think that you have found a better solution please let me know.

This month's problem comes with a solution attached. There are many reasons why the solution given is poor, how many can you find? What is the longest road that you can find an answer for?

The problems that will appear on this page over the next few months will slowly increase in difficulty. The idea behind the feature is to give those of you who are into BASIC programming something to try your skills out on.

Although the problem that we present will not be actually connected with our series on BASIC it will of course be easier to solve if you have been following it.

PROBLEM PAGE

PROBLEM No. 1

There are eight houses on my side of the road and they have even numbers. I noticed that the sum of the house numbers on one side of my house equalled the sum of the house numbers on the other side.

$$\text{i.e. } 2 + 4 + 6 + 8 + 10 = 30$$

$$14 + 16 = 30$$

My uncle lives on the odd side of a much longer road than mine. (more than 100 houses). Yet his house has the same property as mine, that the sum of the house numbers

on one side equals the sum of the house numbers on the other.

Find possible values for :-

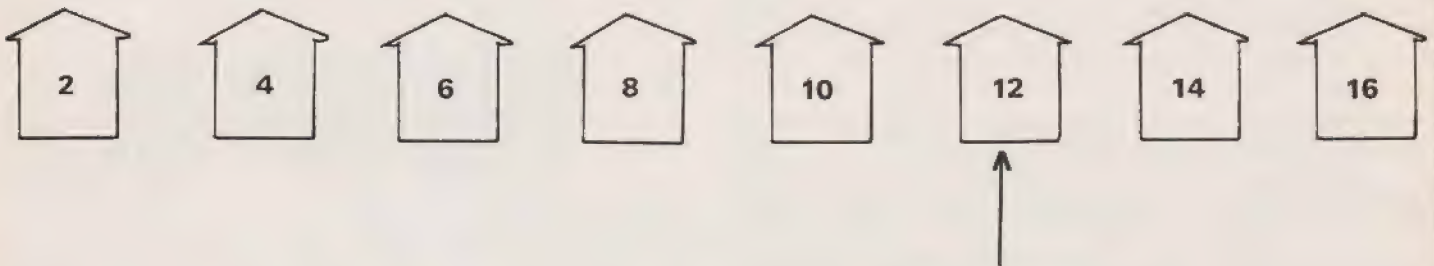
(1) His house number.

(2) The number of houses in the road.

Here is a solution, but there is a much better one — can you find it?

Why is this program poor?

Can you find answers for longer roads?



Trevor Lusty lives here

SOLUTION NO. 1

```
100 REM MY UNCLE LIVES
IN HOUSE - N
120 LET N=1
130 LET N=N+2
140 REM SUM HOUSE NUMBERS
    ON LEFT - L
150 LET L=0
160 FOR I=1 TO N-2 STEP 2
170 LET L=L+I
180 NEXT I
190 REM SUM HOUSE NUMBERS
    ON RIGHT IN - R
200 REM STARTING AT HOUSE
    NUMBER - H
210 LET H=N
220 LET R=0
```

```
230 LET H=H+2
240 LET R=R+H
250 REM DOES THE LEFT SUM
    EQUAL THE RIGHT SUM?
260 IF L=R THEN 300
270 IF L>R THEN 230
280 GOTO 130
290 REM HOW MANY HOUSES?
300 LET T=(H+1)/2
310 IF T>100 THEN 330
320 GOTO 130
330 PRINT "THERE ARE ";T;
    "HOUSES IN THE ROAD"
340 PRINT "UNCLE LIVES AT
    HOUSE NUMBER ";N
350 END
```


The head of NPL's man-computer interaction group talks to CT about machine development and its impact

Dr. Chris Evans is, head of the man-computer interaction group at the National Physical Laboratory (NPL), was trained as a psychologist but for the past 15 years has been intimately involved in computer science. His particular areas of interest at present are the applications of computers in medical and education environments. Chris Evans talks to CT about the development of computers and some of the implications of the staggering drop in the cost of "Computing Power" over the past decade.



The first point to make clear is that computers are not a technological innovation but are an inevitable part of any complex monetary orientated society such as ours. Just as society could not function without modern transport facilities to ship people and cargo around the world so without some form of computing machines, man could not cope with the volume of data processing necessary to support our way of life.

This fact was recognised as long ago as the 17th century when the increasing amount of world trade created a demand for more and more clerks to record the details of cargo movements and to produce the necessary accounting information. This demand for clerical skills was soon to outstrip the available supply of trained personnel. Pascal, a 17th century mathematician and engineer, recognised that if some means of replacing the slow, pen and paper, calculations that made up the bulk of a typical clerks job, then not only would the clerks work be speeded but unskilled labour could be used to operate the machine releasing skilled employees for more demanding work.

Cog In A Wheel

With this in mind Pascal produced a machine based on a system of cogs and wheels that would perform the basics of addition and subtraction mechanically. The machine was however bulky and very expensive, costing some £50 at 17th century prices. The machine could never provide a cost effective method of processing accounting information.

Pascal's machine was dedicated to performing one or two special tasks and it wasn't until the early 19th century Babbage proposed a general purpose machine that could be instructed to perform one of a given set of operations at any particular time, and that a series of such operations could be

EVANS INTERVIEW



Above: The original ACE computer developed at the NPL. It was used to solve the complex mathematical problems created in the various sections of the establishment. (Crown Copyright)
Left: The Commodore PET, smaller but with about the same power courtesy of the silicon chip!

assembled to sequentially process information in any manner desired. By having one central processing unit, performing many tasks, in sequence, instead of a series of dedicated assemblies, the cost of a computer could be considerably reduced.

The level of technology at which Babbage worked, however, still demanded that the machine be based on a series of cogs and wheels and once again no cost effective argument for the use of such a system could be made.

The next major development came about in the mid 19th century with the first census of the American population. The census was to take place every 10 years but some 7 years after the gathering of the data for the first such census the information had still not been processed into a useable form and by that time it, at any rate, was out of date. The method of handling the information, still pen and paper, was clearly never going to be able to cope with the volume of material generated.

What A Card

The administration decided to hold a competition designed to stimulate inventions that would make the task of producing census information a possibility. The winner was a machine designed by Hollerith.

Hollerith's device was based on a punched card system. The information about each individual was to be encoded on a punched card. Then by a system of switches and levers these cards could rapidly be sorted into various

categories and counted. The machine sped up the handling of the task by as much as 500 times.

Machines based on Hollerith's principles were developed and refined to speed up many areas of information processing over the next few decades, but were essentially sorting devices as opposed to computing machines.

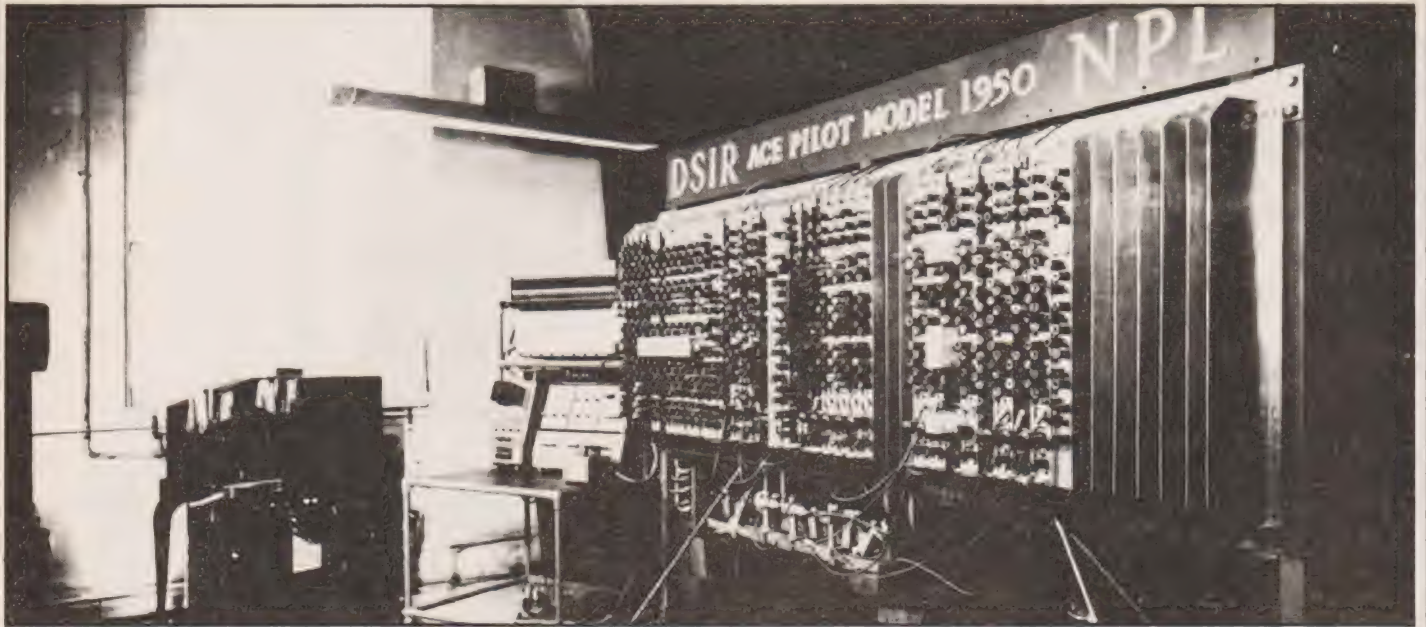
Puzzle Over Hitler

The first computer in a form that would probably be recognisable to us today was the famous Enigma machine used by the British to crack German coding systems during the second world war. The introduction of electronic switches, in the form of valves, greatly increased the speed at which arithmetic operations could be performed and resulted in a device far more powerful than a mechanically based system.

The Enigma machine was however still based on the decimal (base ten) system of arithmetic, which while tailored to human style computations is not very suited to a machines requirements. The binary (base two) arithmetic concept had been known for many years and its rules were well defined. The binary system represents numbers as a series of 1's and 0's. All the operations of addition, subtraction and multiplication and division can readily be performed using binary logic and the major advantage gained is the ease with which a computer can generate and manipulate the 1's and 0's of binary language using electronic switches that are either on (1) or off (0).

Binary machines based on valves were developed, one such being ACE which was for some time used at the NPL. Valves, though, were relatively bulky devices that consumed a lot of power and due to hand assembly techniques demanded by their intricate internal structure, expensive. In terms of size and power requirements, it was

EVANS INTERVIEW



thought that a valve computer equal in power to the human brain would be the size of the Isle of Wight and require Niagara Falls to power it. Some thirty years ago the development of the transistor, with its small physical size, low power requirements and cost, removed the last barriers preventing the production of powerful, mass market computers.

Transistor Advantage

The commercial boom that followed took many by surprise but the advantages in speed and accuracy of processing by computer meant that the computer became an essential part of many business organisations. The cost of computers was still high, however, and only larger companies could justify the installation of their own machine, smaller operations had to resort to buying "spare time" on other peoples machines or making use of computer bureau facilities. A major part of the cost of a computer was still attributable to the amount of labour involved in assembly, for although transistors were cheap, assembling them into the circuits that made up a computer was time consuming. Developments in the field of semiconductor technology were soon to change this.

The transistor had been developed at the Bell Laboratories by a design team lead by William Shockley. *[Shockley left Bell to set up his own company together with 8 other scientists. After 2 years the 8 left after personal disagreements with Shockley and briefly joined Fairchild, soon moving on to set up their own companies in the bay area of San Francisco. The area was subsequently to be known as Silicon Valley. These companies headed by "The Fairchildren" (from Fairchild), each in keen competition were responsible for the latest revolution in the computer industry, the Large Scale Integrated circuit.]* This was a small chip of germanium, treated to produce a single active element. Germanium was not an ideal material however, suffering from a number of undesirable characteristics. Silicon on the other hand produced an almost perfect device and the refinement of manufacturing techniques that allowed more than one transistor to be integrated onto a single "chip" meant that the large logic blocks of a computer could be mass produced — resulting in large savings when assembling a complete computer. From the single transistor per chip in 1957, by 1963, 8 devices were being designed onto the chip and in 1977 a massive 250,000 transistors could be accommodated on a tiny chip of silicon.

The Pilot ACE machine. It was developed to test the ideas behind the full scale model. A section of the machine is now at the Science Museum. (Crown Copyright)

Going back to the previous analogy with this level of sophistication it is possible to reduce the bulk of a computer with the same computing power as a human brain to a size not much bigger than the average car.

Vauxhall Brain?

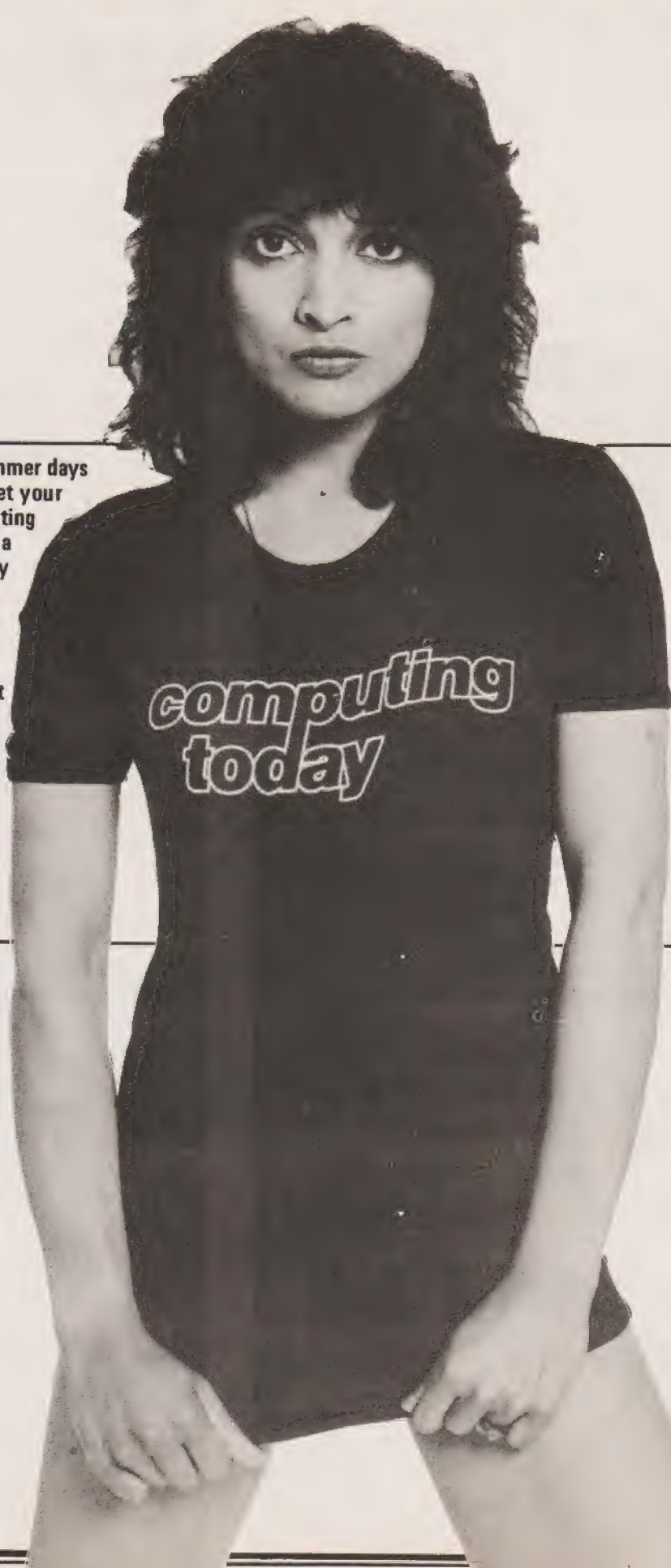
This massive processing power combined with mass manufacturing techniques led manufacturers to look for applications that needed this sort of performance coupled with a large possible market. The pocket calculator was one of the first products to satisfy these requirements, the digital watch being another.

These applications, like Pascal's machine of the 17th century, are deduced and it is the LSI circuit that echos Babbages idea of a general purpose computing machine, that is one of the most important products of LSI circuit development. This is the microprocessor.

MPU On The Moon

The Microprocessor is the Central Processing Unit (CPU) of a computer encapsulated into a single multi pin package. The MPU must be externally programmed by the user for it to be able to perform the specific operations demanded of it. Microprocessors have found applications ranging from controlling sewing machines and microwave ovens (where they replace traditional mechanical control systems) to producing chess playing machines, not forgetting making the Apollo moon landing possible. It's also the microprocessor that is responsible for the fact that today computers equal in power to the room sized machines costing 10's of thousands of pounds of 10 years ago can today be bought for less than £500 and will fit quite comfortably on a coffee table. And that really is where we came in

Dr. Chris Evans has recorded a series of interviews with some of the pioneers of computing in the early 50's and 60's, for the Science Museum. Copies of the tapes can be obtained from the Museum at Exhibition Road, London S.W.7. Dr. Evans has also published many books, among them the recently produced Dictionary of Psychology from Arrow.

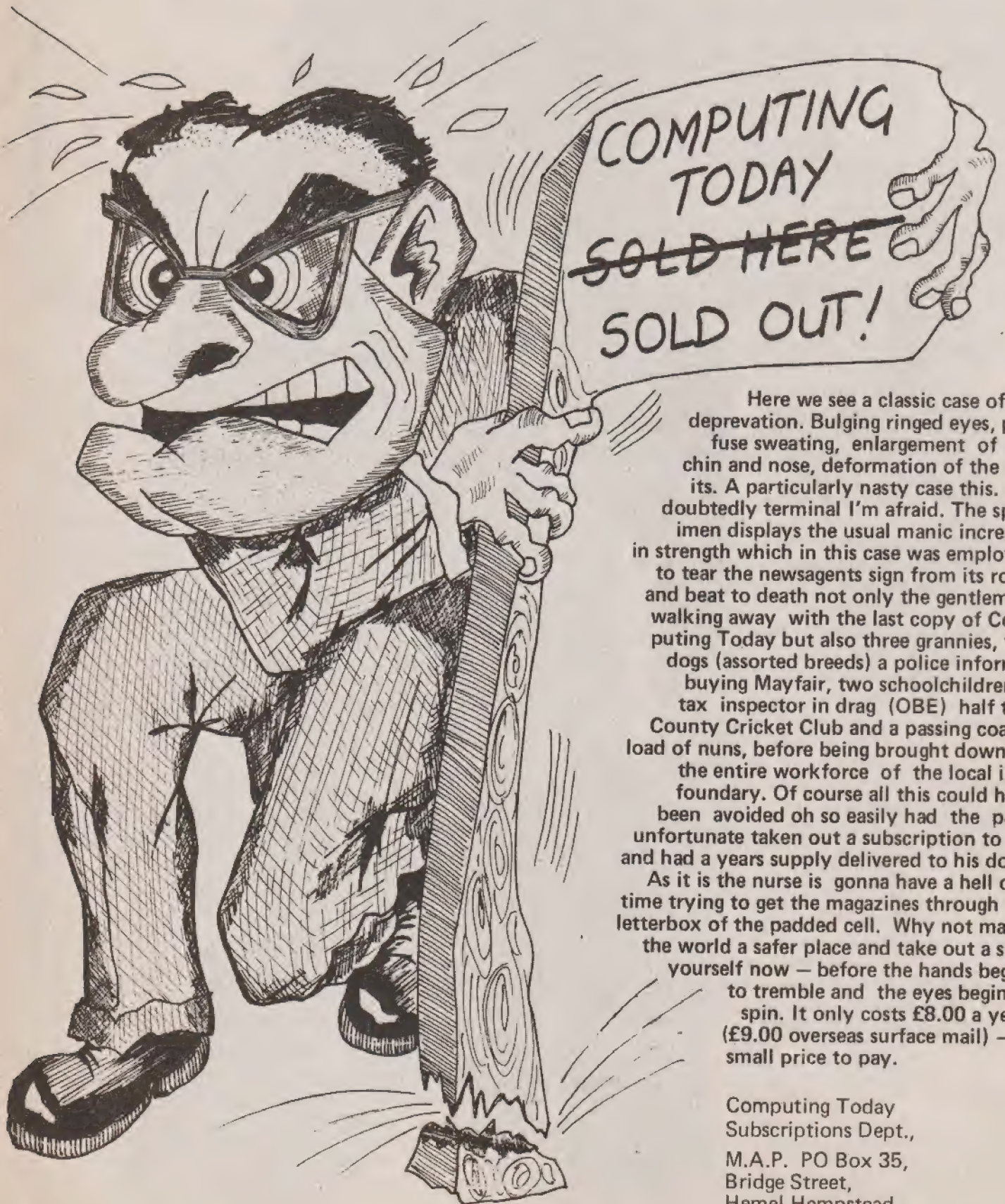


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ARRRGGGHHH.....



Here we see a classic case of CT deprivation. Bulging ringed eyes, profuse sweating, enlargement of the chin and nose, deformation of the digits. A particularly nasty case this. Undoubtedly terminal I'm afraid. The specimen displays the usual manic increase in strength which in this case was employed to tear the newsagents sign from its roots and beat to death not only the gentleman walking away with the last copy of Computing Today but also three grannies, five dogs (assorted breeds) a police informer buying Mayfair, two schoolchildren, a tax inspector in drag (OBE) half the County Cricket Club and a passing coach load of nuns, before being brought down by the entire workforce of the local iron foundry. Of course all this could have been avoided oh so easily had the poor unfortunate taken out a subscription to CT and had a years supply delivered to his door. As it is the nurse is gonna have a hell of a time trying to get the magazines through the letterbox of the padded cell. Why not make the world a safer place and take out a sub yourself now — before the hands begin to tremble and the eyes begin to spin. It only costs £8.00 a year (£9.00 overseas surface mail) — a small price to pay.

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- *System expandable to ½ Mbyte on-line storage (4 drives).
- *Dual head and 2D versions provide 2 Mbytes on-line.
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- *Dedicated Intel 8048 microprocessor and 1771 FDC minimise PET software overhead.
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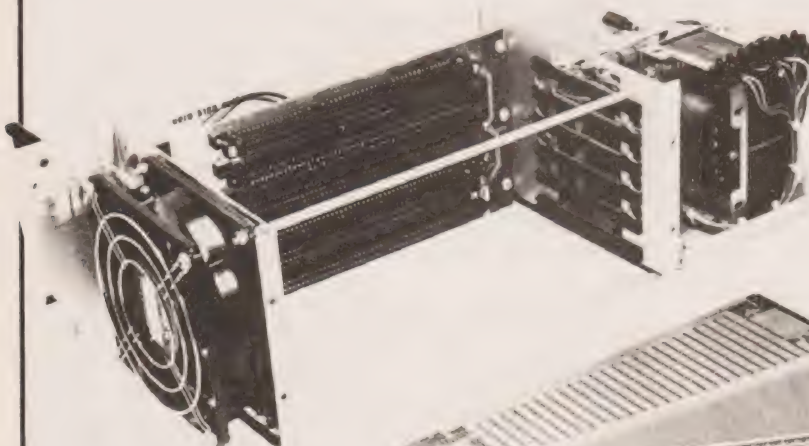
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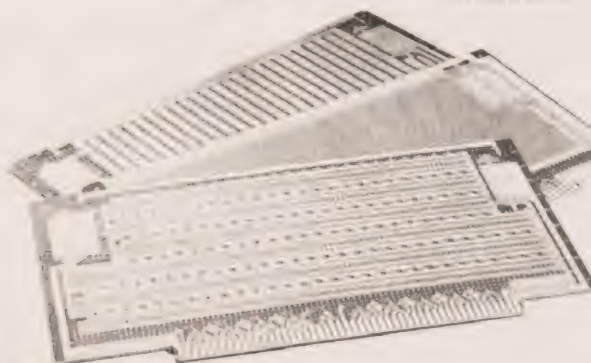
S100-the British way



The Vero S100 Sub Rack is a 19" rack mountable development kit, complete with its own power supply and backplane motherboard, for the construction and evaluation of microprocessor based systems to the S100 format. The power supply provides three voltage levels — +8V, +18V and -18V. The Sub Rack has its own cooling fan providing airflow across the boards and the power supply. A full range of allied items to enable a complete system to be constructed are available.

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48-8345K	Mk. II D Series Case
75-2867G	Keyboard Console
79-1729L	Verowire Wiring Kit



Keep track of your books with Triton

This personal accounting program is written for Triton using 8K RAM card, 7K floating point BASIC and teletype. Simple double-entry book-keeping is employed in order to ensure arithmetical accuracy and the program provides for analysis of all income or expenditure according to the requirements of the user in the form of a list of balances which can be printed either before or after data is entered. Procedural instructions appear on the VDU. Provision has also been made for selected account balances to be expressed as a percentage of income. The information printed for each individual transaction gives the date (DDMM), cheque or reference number, serial number for the entry (computed automatically providing a continuity check for each printout) and the name of, and amount entered into, the two or more accounts involved.

Double-entry necessitates two or more entries for each transaction — for example:—

- 1 — Electricity bill paid by cheque. A negative amount would be shown for both the electricity a/c and the bank account.
- 2 — Salary credited to bank account. A positive amount would be shown for both the salary account and the bank account.
- 3 — Gas bill wrongly charged to electricity account. A negative amount would be shown for the gas account and a positive amount for the electricity account thus leaving overall totals unaltered whilst correcting the two accounts involved.
- 4 — A transfer of funds between bank, building society or post office accounts would entail two separate transactions. Firstly negative entries in both the account giving the funds and the 'transfers' account. Secondly positive entries in both the account receiving the funds and the 'transfers' account. A zero balance would then result in the 'transfer' account whilst the bank etc. balances would be adjusted to reflect the movement of funds.

The program provides for the retention of text and balances (as variables) on cassette and the final screen display gives

the necessary start and end addresses. Line number 0 limits the amount of memory used to avoid needless recording of zero bytes but there is nevertheless a useful amount of free space for direct additions to the program. This can easily be verified by executing a hexdump with the program loaded. To return to BASIC from the monitor you must enter 'G' with a start address E017 in order not to clear the program.

It is most important to remember that the RUN command initialises all variables and must not, repeat not be used after loading from cassette. Instead use 'GOTO 0' as a 'PSEUDO' command.

The Program

The listing provides for 34 income/expenditure accounts and 4 bank, building society or post office accounts. The accounts have been named to cover the usual headings with the remainder labelled as 'spare' — these can be easily edited to suit the needs of the user.

The number of accounts which can be accommodated is dependant on the number of variables and arrays which can be fitted into the available memory and could well be sufficient to enable the program to be used for business purposes.

This program has enabled the author to dispense with the tedious task of writing-up and casting manually prepared accounting records which have been replaced by a ring-binder to hold the prints.

When initiating the program do not request a list of balances until an entry has been made in the salary account otherwise the percentage calculations will produce an error message.

To transfer the balances from an existing manual accounting system make one composite input entry as for example in Figure 1. If starting with a bank balance for which no analysis is available, enter the amount (positive) in the opening balances account (no.32) and in the bank account (no. 91). See example Figure 2. Figure 3 shows specimen input enyries and Figure 4 shows the resulting listing of balances.

After the final list of balances has been printed for

TRITON ACCOUNTS

```

DATE OF LAST PRINT..... 0
DATE OF LAST TRANSACTION 0
NUMBER OF LAST ENTRY.... 0
*****
DATE OF THIS PRINT 1807
-----
PERSONAL ACCOUNTS - 1979
*****
TRANSACTION DATE..... 1807
ENTRY NUMBER..... 1
CHEQUE/REFERENCE NO.. 0
COMPUTER EQUIPMENT...>-39.00
WIFE'S ALLOWANCE...>-175.00
ELECTRICITY.....>-55.85
GARAGE RENT.....>-38.75
GAS.....>-109.50
HOUSEKEEPING.....>-478.00
MILK.....>-29.70
GENERAL RATES.....>-130.00
ROAD FUND LICENCE...>-50.00
MORTGAGE REPAYMENT...>-475.78
TELEPHONE CHARGES...>-17.74
TV LICENCE FEE.....>-25.00
WATER RATES.....>-18.42
SALARY - NET.....>1822.49
BANK ACCOUNT.....>130.75
*****
TOTAL INCOME/EXPENDITURE..... 130.75
TOTAL BANK AND B/S BALANCES..... 130.75
BALANCES AGREE

```

Fig.1. A composite entry to start off the Account package.

```

DATE OF LAST PRINT..... 0
DATE OF LAST TRANSACTION 0
NUMBER OF LAST ENTRY.... 0
*****
DATE OF THIS PRINT 1807
-----
PERSONAL ACCOUNTS - 1979
*****
TRANSACTION DATE..... 127
ENTRY NUMBER..... 1
CHEQUE/REFERENCE NO.. 3
SALARY - NET.....>320.70
BANK ACCOUNT.....>320.70
*****
TRANSACTION DATE..... 907
ENTRY NUMBER..... 2
CHEQUE/REFERENCE NO.. 1111
GAS.....>-58.87
BANK ACCOUNT.....>-58.87
*****
TRANSACTION DATE..... 1107
ENTRY NUMBER..... 3
CHEQUE/REFERENCE NO.. 1112
HOUSEKEEPING.....>-110.00
BANK ACCOUNT.....>-110.00
*****
TRANSACTION DATE..... 1807
ENTRY NUMBER..... 4
CHEQUE/REFERENCE NO.. 1113
TELEPHONE CHARGES...>-19.93
BANK ACCOUNT.....>-19.93
*****
TRANSACTION DATE..... 1307
ENTRY NUMBER..... 5
CHEQUE/REFERENCE NO.. 1114
HOUSEKEEPING.....>-25.00
BANK ACCOUNT.....>-25.00
*****
TOTAL INCOME/EXPENDITURE..... 130.75
TOTAL BANK AND B/S BALANCES..... 130.75
BALANCES AGREE

```

Fig.3. Specimen entries to the bank balance.

```

DATE OF LAST PRINT..... 0
DATE OF LAST TRANSACTION 0
NUMBER OF LAST ENTRY.... 0
*****
DATE OF THIS PRINT 1807
-----
PERSONAL ACCOUNTS - 1979
*****
TRANSACTION DATE..... 1807
ENTRY NUMBER..... 1
CHEQUE/REFERENCE NO.. 2
OPENING BALANCES.....>130.75
BANK ACCOUNT.....>130.75
*****
TOTAL INCOME/EXPENDITURE..... 130.75
TOTAL BANK AND B/S BALANCES..... 130.75
BALANCES AGREE

```

Fig.2. Starting the bank balance.

```

BALANCES C/F - PRINT DATE 1807
-----
1  SRAPE..... 0.00
2  CAR COSTS & PETROL..... 0.00 (-0.00 * SALARY)
3  SRAPE..... 0.00
4  COMPUTER EQUIPMENT..... 0.00
5  WIFE'S ALLOWANCE..... 0.00 (-0.00 * SALARY)
6  LOANS TO WIFE..... 0.00
7  POCKET MONEY - CHILDREN 0.00
8  DECORATIONS..... 0.00 (-0.00 * SALARY)
9  ELECTRICITY..... 0.00 (-0.00 * SALARY)
10 FURNITURE ETC..... 0.00 (-0.00 * SALARY)
11 GARAGE RENT..... 0.00
12 GAS.....-58.87 ( 13.35 * SALARY)
13 HOUSEKEEPING.....-135.00 ( 40.10 * SALARY)
14 INTEREST RECEIVED/PAID 0.00
15 MISCELLANEOUS..... 0.00
16 MILK..... 0.00
17 SRAPE..... 0.00
18 SRAPE..... 0.00
19 RATES..... 0.00 (-0.00 * SALARY)
20 REDIFFUSION..... 0.00
21 ROAD FUND LICENCE..... 0.00
22 SALARY.....320.70
23 MORTGAGE REPAYMENT..... 0.00 (-0.00 * SALARY)
24 HEATING MAINTENANCE... 0.00 (-0.00 * SALARY)
25 TELEPHONE.....-19.93
26 TV LICENCE..... 0.00
27 WASHING MACHINE REPAIR 0.00
28 WATER RATES..... 0.00 (-0.00 * SALARY)
29 TRAIN FARES..... 0.00
30 CAR PARTS/SERVICING... 0.00
31 BANK CHARGES..... 0.00
32 OPENING BALANCES..... 0.00
33 TRANSFERS..... 0.00
34 INVESTMENTS..... 0.00
-----
TOTAL INCOME/EXPENDITURE IS... 130.75
-----
91 BANK BALANCE..... 130.75
92 BLDG. SOC. BALANCE..... 0.00
93 POST OFFICE SAVINGS A/C 0.00
94 SRAPE (BANK) BALANCE... 0.00
-----
TOTAL BANK AND B/S BALANCES... 130.75
-----

```

Fig.4. Output listing for the Account.

TRITON ACCOUNTS

the year (or other period of account) the heading can be suitably altered and all variables cleared to start the new account. The previous total income/expenditure should then be entered in the 'opening balances' account and the bank etc. balances reinstated as they were. The analysis of income/expenditure then starts afresh. The program should run with a minimum of modification on other (floating point) BASIC's. The statements which might need alteration are:—

<> = not equal to.

PRINT #0# = print whole numbers without decimals.

PRINT #2Z# = print 2 decimal places with zeros.

subscripted variables i.e. C1, C2, C3 etc.

POKE 5121,0 = switch to VDU.

POKE 5121,85 = switch to printer.

POKE statements in line 0:— These limit the amount of memory available to the BASIC interpreter and are related to the start and finish addresses given at the end of the program for the transfer to cassette.

The requirement in this connection is that adequate memory space should be made available for text and the variables to be saved. The program as written provides 7.5K bytes. The 7K floating point BASIC establishes Triton as a most useful instrument in the field of home management, club and society accounting and this program could well be expanded to embrace income tax, VAT and budgetary control.

PERSONAL ACCOUNTS - PROGRAM LISTING

```

>LIST
0 POKE5070,00:POKE5121,85
1 J1=0:01=0
2 POKE5121,85
3 PRINT#0
4 PRINT"DATE OF LAST PRINT.....",K1
5 PRINT"DATE OF LAST TRANSACTION",T6
6 PRINT"NUMBER OF LAST ENTRY.....",S
10 PRINT"*****"
15 POKE5121,0
25 PRINT"ENTER DATE OF THIS PRINT"
30 INPUT,K1
35 POKE5121,85
35 PRINT#0,PRINT"DATE OF THIS PRINT",K1
40 PRINT"*****"
50 PRINT"PERSONAL ACCOUNTS - 1979"
60 PRINT"*****"
61 PRINT#2Z#
62 POKE5121,00
65 PRINT"TO PRINT OPENING BALANCES ENTER 70"
66 PRINT"TO RECORD TRANSACTION ENTER 820"
67 INPUT,01
68 GOTOG1
70 POKE5121,85:GOTO80
75 POKE5121,85:PRINT#0,PRINT"BALANCES C/F - PRINT DATE",K1:GOTO80
80 PRINT"BALANCES BROUGHT FORWARD"
90 PRINT"*****"
95 PRINT#2Z#
100 PRINT"1 SPARE.....",B1
110 PRINT"2 CAR COSTS & PETROL.....",B2,"(",B2/D4*-100,"% SALARY)"
120 PRINT"3 SPARE.....",B3
130 PRINT"4 COMPUTER EQUIPMENT.....",B4
140 PRINT"5 WIFE'S ALLOWANCE.....",B5,"(",B5/D4*-100,"% SALARY)"
150 PRINT"6 LOANS TO WIFE.....",B6
160 PRINT"7 POCKET MONEY - CHILDREN",B7
170 PRINT"8 DECORATING.....",B8,"(",B8/D4*-100,"% SALARY)"
180 PRINT"9 ELECTRICITY.....",B9,"(",B9/D4*-100,"% SALARY)"
190 PRINT"10 FURNITURE ETC.....",C1,"(",C1/D4*-100,"% SALARY)"
200 PRINT"11 GARAGE RENT.....",C2
210 PRINT"12 GAS.....",C3,"(",C3/D4*-100,"% SALARY)"
220 PRINT"13 HOUSEKEEPING.....",C4,"(",C4/D4*-100,"% SALARY)"
230 PRINT"14 INTEREST RECEIVED/PAID.....",C5
240 PRINT"15 MISCELLANEOUS.....",C6
250 PRINT"16 MILK.....",C7
260 PRINT"17 SPARE.....",C8
270 PRINT"18 SPARE.....",C9
280 PRINT"19 RATES.....",D1,"(",D1/D4*-100,"% SALARY)"
290 PRINT"20 REDIFFUSION.....",D2
300 PRINT"21 ROAD FUND LICENCE.....",D3
310 PRINT"22 SALARY.....",D4
320 PRINT"23 MORTGAGE REPAYMENT.....",D5,"(",D5/D4*-100,"% SALARY)"
330 PRINT"24 HEATING MAINTENANCE.....",D6,"(",D6/D4*-100,"% SALARY)"
340 PRINT"25 TELEPHONE.....",D7
350 PRINT"26 TV LICENCE.....",D8
360 PRINT"27 WASHING MACHINE REPAIR.....",D9
370 PRINT"28 WATER RATES.....",E1,"(",E1/D4*-100,"% SALARY)"
380 PRINT"29 TRAIN FARES.....",E2
390 PRINT"30 CAR PARTS/SERVICING.....",E3
400 PRINT"31 BANK CHARGES.....",E4
410 PRINT"32 OPENING BALANCES.....",E5
420 PRINT"33 TRANSFERS.....",E6
430 PRINT"34 INVESTMENTS.....",E7
500 T1=B1+B2+B3+B4+B5+B6+B7+B8+B9
510 T2=C1+C2+C3+C4+C5+C6+C7+C8+C9
520 T3=D1+D2+D3+D4+D5+D6+D7+D8+D9
530 T4=T1+T2+T3+E1+E2+E3+E4+E5+E6+E7
540 PRINT"-----"
550 PRINT"TOTAL INCOME/EXPENDITURE IS.....",T4
560 PRINT"-----"
600 PRINT"91 BANK BALANCE.....",F1
610 PRINT"92 BLDG. SOC. BALANCE.....",F2
620 PRINT"93 POST OFFICE SAVINGS A/C",F3
630 PRINT"94 SPARE (BANK) BALANCE.....",F4
650 T5=F1+F2+F3+F4
700 PRINT"-----"
710 PRINT"TOTAL BANK AND B/S BALANCES.....",T5
720 PRINT"-----"
750 IFJ1=75GOTO9000
800 PRINT
810 POKE5121,00
820 PRINT
822 PRINT#0
823 PRINT"ENTER TRANSACTION DATE DDMM",INPUT,T6
824 PRINT"ENTER CHEQUE OR REFERENCE NUMBER - LAST FOUR ONLY",
825 INPUT,01
826 POKE5121,85:PRINT#0,PRINT"TRANSACTION DATE.....",T6
827 S=S+1
828 PRINT"ENTRY NUMBER.....",S
829 PRINT"CHEQUE/REFERENCE NO.....",01
830 POKE5121,00:PRINT"ENTER A/C NO. OR 0 TO COMPLETE ENTRY",
832 INPUT,T7
840 PRINT#2Z#
850 IF T7=0GOTO2000
855 POKE5121,85
860 JOTOT7+870
871 PRINT"SPARE.....",INPUT,V1:B1=B1+V1:GOTO830
872 PRINT"CAR/PETROL.....",INPUT,V2:B2=B2+V2:GOTO830
873 PRINT"SPARE.....",INPUT,V3:B3=B3+V3:GOTO830
874 PRINT"COMPUTER EQUIPMENT.....",INPUT,V4:B4=B4+V4:GOTO830
875 PRINT"WIFE'S ALLOWANCE.....",INPUT,V5:B5=B5+V5:GOTO830
876 PRINT"LOANS TO WIFE.....",INPUT,V6:B6=B6+V6:GOTO830
877 PRINT"POCKET MONEY.....",INPUT,V7:B7=B7+V7:GOTO830
878 PRINT"DECORATING.....",INPUT,V8:B8=B8+V8:GOTO830
879 PRINT"ELECTRICITY.....",INPUT,V9:B9=B9+V9:GOTO830
880 PRINT"FURNITURE ETC.....",INPUT,V1:C1=C1+V1:GOTO830
881 PRINT"GARAGE RENT.....",INPUT,V2:C2=C2+V2:GOTO830
882 PRINT"GAS.....",INPUT,V3:C3=C3+V3:GOTO830
883 PRINT"HOUSEKEEPING.....",INPUT,V4:C4=C4+V4:GOTO830
884 PRINT"INTEREST REC'D/PAID.....",INPUT,V5:C5=C5+V5:GOTO830
885 PRINT"MISCELLANEOUS.....",INPUT,V6:C6=C6+V6:GOTO830
886 PRINT"MILK.....",INPUT,V7:C7=C7+V7:GOTO830
887 PRINT"SPARE.....",INPUT,V8:C8=C8+V8:GOTO830
888 PRINT"SPARE.....",INPUT,V9:C9=C9+V9:GOTO830
889 PRINT"GENERAL RATES.....",INPUT,X1:D1=D1+X1:GOTO830
890 PRINT"REDIFFUSION RENTAL.....",INPUT,X2:D2=D2+X2:GOTO830
891 PRINT"ROAD FUND LICENCE.....",INPUT,X3:D3=D3+X3:GOTO830
892 PRINT"SALARY - NET.....",INPUT,X4:D4=D4+X4:GOTO830
893 PRINT"MORTGAGE REPAYMENT.....",INPUT,X5:D5=D5+X5:GOTO830
894 PRINT"HEATING MAINTENANCE.....",INPUT,X6:D6=D6+X6:GOTO830
895 PRINT"TELEPHONE CHARGES.....",INPUT,X7:D7=D7+X7:GOTO830
896 PRINT"TV LICENCE FEE.....",INPUT,X8:D8=D8+X8:GOTO830
897 PRINT"WASHING M/C REPAIRS.....",INPUT,X9:D9=D9+X9:GOTO830
898 PRINT"WATER RATES.....",INPUT,Y1:E1=E1+Y1:GOTO830
899 PRINT"TRAIN FARES.....",INPUT,Y2:E2=E2+Y2:GOTO830
900 PRINT"CAR PARTS/SERVICING.....",INPUT,Y3:E3=E3+Y3:GOTO830
901 PRINT"BANK CHARGES.....",INPUT,Y4:E4=E4+Y4:GOTO830
902 PRINT"OPENING BALANCES.....",INPUT,Y5:E5=E5+Y5:GOTO830
903 PRINT"TRANSFERS.....",INPUT,Y6:E6=E6+Y6:GOTO830
904 PRINT"INVESTMENTS.....",INPUT,Y7:E7=E7+Y7:GOTO830
2000 PRINT"ENTER BANK OR B/S CODE"
2002 PRINT"BANK=91 B/S=92 POSB=93 SPARE=94"
2004 PRINT"ADJUSTING ENTRY=95",INPUT,S1:POKE5121,85
2010 JOTOS1+2000
2091 PRINT"BANK ACCOUNT.....",INPUT,S2:F1=F1+S2:GOTO3000
2092 PRINT"BUILDING SOCIETY A/C",INPUT,S3:F2=F2+S3:GOTO3000
2093 PRINT"POST OFFICE ACCOUNT.....",INPUT,S4:F3=F3+S4:GOTO3000
2094 PRINT"SPARE (BANK) ACCOUNT",INPUT,S5:F4=F4+S5:GOTO3000
2095 PRINT"ADJUSTING ENTRY ONLY",GOTO3000
2100 POKE5121,00
3000 PRINT"*****"
3005 POKE5121,00:PRINT"TO MAKE FURTHER ENTRY ENTER 1"
3010 PRINT"TO PRINT TOTALS AND CLOSE ENTER 2"
3020 INPUT,S6
3030 IFS6=1GOTO820
3040 IFS6=0GOTO4000
4020 H1=B1+D2+B3+B4+B5+B6+B7+B8+B9
4030 H2=C1+C2+C3+C4+C5+C6+C7+C8+C9
4040 H3=D1+D2+D3+D4+D5+D6+D7+D8+D9
4050 H4=M1+M2+M3+E1+E2+E3+E4+E5+E6+E7
4060 POKE5121,85
4062 PRINT"TOTAL INCOME/EXPENDITURE.....",H4
4070 H5=F1+F2+F3+F4
5010 PRINT"TOTAL BANK AND B/S BALANCES.....",H5
5022 IFH4=H5PRINT"BALANCES DISAPPEAL - PLEASE EXAMINE"
5025 IFH4=H5GOTO8000
5030 IFH4=H5PRINT"BALANCES DISAPPEAL - PLEASE EXAMINE"
5040 PRINT"THE DIFFERENCE AND ADJUST"
5050 POKE5121,00:PRINT"TO PRINT CLOSING BALANCES ENTER 75"
5070 PRINT"TO FINISH ENTER 9999"
5080 INPUT,J1:GOTOJ1
9000 POKE5121,00:PRINT"END OF RUN"
9010 PRINT"*****ATTENTION TO ENTER*****"
9020 PRINT"START ADDRESS 3000 - END ADDRESS 13000"
9030 END

```


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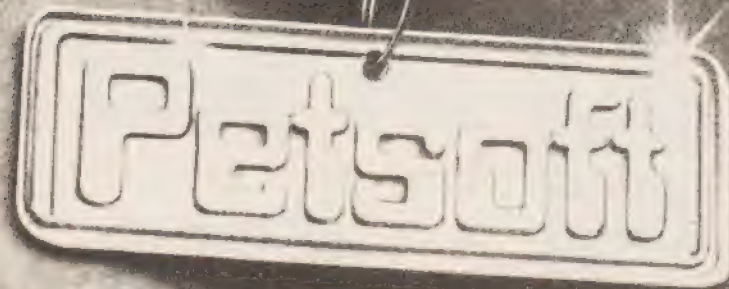
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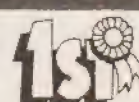


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POWER SUPPLY INTERLOCK

Mr. P.L. Newland.

A power supply interlock to prevent heartache!

With the reduction in price of dynamic memories, their use is becoming attractive for home computer use (see, for example, Computing Today, April — 16K expansion). The low cost dynamic RAMs require three power supplies; —5 volts and +12 volts. It seems to be a little known fact just how critical these supplies are to each other. To quote the Texas Instruments MOS Memory Data Book:—

"VBB (—5 volt) must be applied to the device before or at the same time as the other supplies and removed last. Failure to observe this precaution will cause dissipation in excess of the absolute maximum ratings due to internal forward bias conditions. This also applies to system use where failure of the VBB supply must immediately shut down the other supplies."

Most home computers use integrated circuit regulators of the LM309K or 7800 series. These have internal foldback current limiting and this may be used to advantage to add the very simple interlock circuit of Fig. 1.

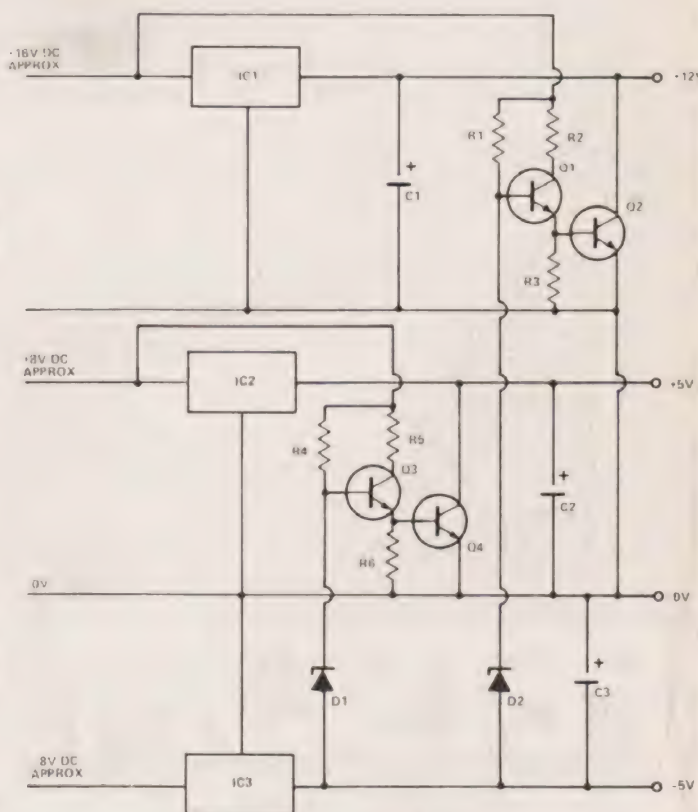


Fig.1 The circuit diagram for the power supply interlock.

HOW IT WORKS

If the negative supply is more than 3V7 negative, the currents in resistors R1 and R4 are diverted through zener diodes D1 and D2. Transistors Q1 — Q4 are therefore normally cut-off. If the negative supply drops below 3.7 volts, the transistors become forward biased and the currents from resistors R1 and R4 are amplified by Q1 and Q3 which turns Q2 and Q4 hard on. The positive regulators IC1 and IC2 are therefore clamped into their foldback mode and the dynamic RAMs are protected. On switch-on, the negative supply must reach 3V7 before the clamp transistors are released. Also, any fault in the negative supply, or a short across it, will immediately clamp both positive supplies close to zero volts.

PARTS LIST

Resistors (All ¼ W unless specified)

R1	4k7	
R2	270R	(1 Watt)
R3,6	2k2	
R4	1K	
R5	47R	(2 Watt)

Capacitors

C1,2,3	4700 uF (electrolytic)
--------	------------------------

Semiconductors

IC1	7812
IC2	7805
IC3	7905
Q1,3	BFY50
Q2,4	TIP3055
D1, D2	400mW Zener, 5V1

Miscellaneous

Heatsinks for Q2, Q4.

Dear Sir,

TRS-80 MINI LEDGER PROGRAM : AUGUST ISSUE.

With reference to the above the program, as printed, contains the following errors:—

- (a) Line 420 Insert a comma after '128,68'
- (b) Line 740 Semi-colon missing between end of quotes and Z1.
- (c) Line 770

(i) Changes the minus signs in quotes to signs.

(ii) Semi-colon missing after quotes, should be inserted between quotes and P÷Z3—Z2

I will be grateful if you will pass the attached letter to your accounts branch.

Yours sincerely,
W.H.Davies.

98, Henley Road,
Cheltenham,
Glos. GL51 0LD

Dear Sir,

As an avid reader of your excellent magazine, may I say how much I enjoy the wide variety of articles you present, particularly the "Softspot" which has provided some exciting and well-documented programs.

I was surprised therefore, to see in the "MINI LEDGER" article, an irrelevant and superfluous hexadecimal listing of the previously listed BASIC program, wasting both time and valuable space.

Is it not obvious that any Z80-based micro capable of running the hexa. program as listed, will be equipped with a BASIC interpreter and, therefore, the means to input a program in the form of BASIC statements, thus making such a listing redundant.

An hexadecimal program listing is only of value where:—

- a) a BASIC interpreter is available for the program run, but no monitor is provided to accept the input of BASIC program statements . . . (unheard of in my experience).
- b) the program is at machine-code-level and can be run directly, (ie. not under control of a BASIC interpreter). Such a program is invariably quicker, shorter and more efficient than an equivalent BASIC program.

Yours sincerely,
J.R.Lawton

2, Gwenys Crescent,
Stoke-On-Trent,
ST3 2DB

Dear Sir,

You've goofed again!

The 'Mini Ledger' article in your August issue is chock full of misleading statements.

The 'Hexadecimal' listing is no such thing. It is a 'hardware' print of the TRS80 BASIC source program. It is not even a listing of the program printed in the article (check the line numbers if you don't believe me).

So anyone without BASIC had better forget this program.

You've wasted three pages of your magazine printing a useless listing!

Maybe someone should check articles before you publish them!

Yours
R.J.Hughes.

11, Inman Road,
Earlsfield,
London,
SW18 3BB.

Dear Sirs,

In most technical publications, to which I subscribe, space is at an absolute premium.

However, this does not appear to be the case with CT. Apparently Mr. WH Davies (Aug '79) is under a misconception regarding the difference between a compiler, generating machine code, and an interpreter, producing an encoded source, intended for subsequent execution by the same.

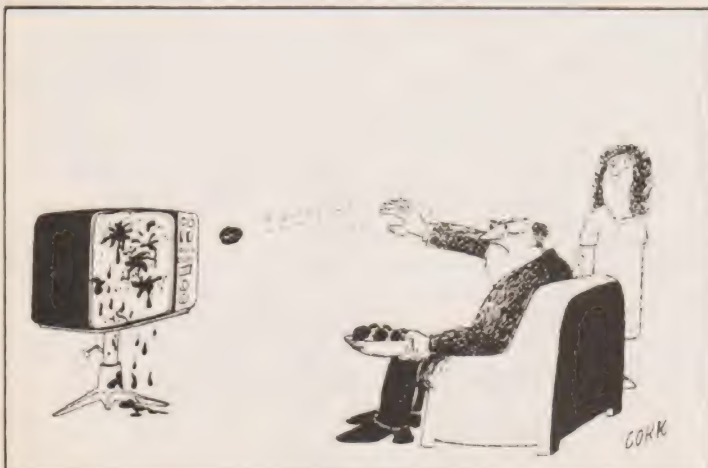
It seems this impression extends to the editorial staff, who have approved the inclusion of three pages of redundant hexadecimal code, following the program listing.

This space could have been better employed in a number of different ways, such as explaining the differences between compilers and interpreters (assuming you are aware of them).

I do not wish to criticise Mr Davies, who was acting in good faith when he submitted his article. The blame must be laid squarely on the shoulders of the editorial staff for failing in their job.

I hope you will find the space to print this letter.

Yours Temporarily Annoyed,
JD Wheatley,
Programmer LBI.



Dear Sir,

I must comment on Mr.T.M.Spence's letter in the July issue, with regard to Mr. Ingleson's letter about his Nascom.

Mr. Spence's fault was of his own making (easily done considering the no. of joints to be made). Mr. Ingleson's faults were not, nor were mine. For those who may be having problems, perhaps my experiences may be of help.

1. To check for etching faults on Nascom, the best place to look is where the print runs closest to and alongside the I.C. pins. Particularly on the component side of the board. The print may link to a pin it should not go to, and once the I.C. bases are fitted you will not see it. If you have already assembled your kit, play safe and remove all I.C.'s before making resistance tests and put them safely away. Note. The faulty print looks normal, use your print diagram. In my case pins 5 and 7 were linked on I.C.55 and pins 2 and 5 were linked on I.C.5.

2. Some kits may need a mod to I.C.18 if the space bar deletes the last character. Link pins 5 and 12 and disconnect pin 5 from the I.C. base. (Bend I.C. leg).

3. If problems are with cass interface, even after Nascoms recommendations are carried out, check transistors for low or no gain. In my case TR5. I have used a BC148 in its place. 4. If memory locations are corrupted after executing and then resetting, try a different series of memory chips. Borrow from a friend if you can. Swopping VDU and USER RAM may not be a valid test as they are connected differently as you will see on the diagram. My Nascom will not tolerate 21L02B chips in USER RAM. RAM for VDU does not seem critical.

As anyone can see these faults were not caused by the constructor.

The working kit is very good and I am pleased with it, so too I believe is Mr. Ingleson. More attention to quality control and it will be better still.

Please keep up the Nascom Packages, and how about an article on Pitfalls and practice using Z80 Machine Code. Keep up the good work.

Yours sincerely,
D.J.Child.

6, Bank,
Eccleshill,
Bradford
BD10 8BH.

Dear Sir,

I am writing an elementary book on "MICRO-PROCESSORS", to be published by the Babani Press.

I would like to include a list of "Amateur Computer Societies" at the end of the book. Could you print a small request in 'Computing Today' for addresses of Computer Societies in Britain, Canada, Australia, N.Z. I want to hear from societies who welcome 'raw beginners' as members

I would also like to know if any university or college in Britain offers or is planning to introduce a degree course in "MICROPROCESSOR STUDIES" or "MICRO-ELECTRONICS TECHNOLOGY".

Thanks
R.N.Soar.

c/o Babani Press,
The Grampians,
Shepherds Bush Road,
London W6 7NF.

Dear Sir,

In the August (august?) issue of C.T., E.B.Simmons brought up a few points on computer vocabulary, most of which were quite valid. However, language is developed by usage, and within the computer industry (where I have languished for seven years!), the word describing one OR more pieces of information has always been DATA, not DATUM.

In fact, neither are strictly correct, since a datum is a measurement reference point, whereas an item of computer data is an attribute of the problem being solved. Rather a subtle difference, I'm afraid.

Incidentally, I wonder if he/she has ever tried to analyse post codes on a computer? It's not as simple as it might seem.

Yours,
Pete Newman
Programming Consultant.

Atkins On-Line Limited,
Fourmost House 12-22 West Street,
Epsom, Surrey KT18 7RH

Dear Sir,

Since I am myself the owner of a disk-based TRS-80, I was intrigued by the article 'Mini Ledger' by Mr.W.H.Davies in your August issue. Lest any of your readers be misled, could I point out that the TRS-80 BASIC is an interpreter, not a compiler. The hexadecimal listings which you print are in fact simply the encoded representation of the BASIC source code. They are not Z80 machine code, and are therefore of no value to Z80 users without the TRS-80 BASIC.

Yours faithfully,
T.J. Bourne.

16, Crossways,
Laverstock Green,
Hemel Hempstead,
Herts HP3 8PU.

Dear Sir,

Has there been a printing error in the list of connections in Table 2 of MPU's by experiment as C20 shows a second 560R? The capacitor C* would then be in the C21 connections.

Yours sincerely,
W.H.Edwards.

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Millhouses,
Sheffield S72GY
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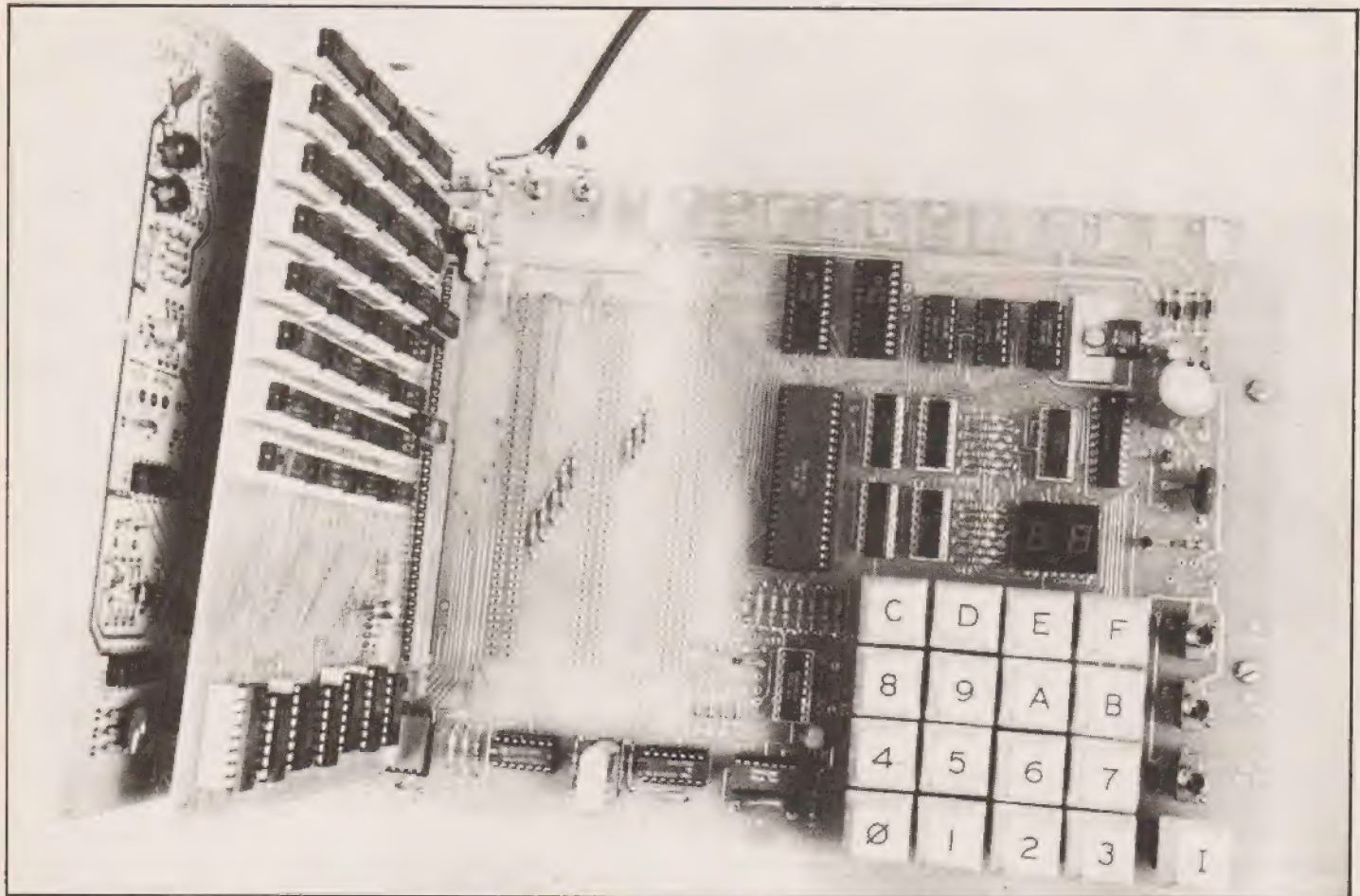
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David Sinfield reviews this Tiny Basic gnome computer

The minimal Netronics ELF II system consists of an RCA 1802 CPU, 256 bytes of RAM, an RCA 1852 VDU controller, a 2 digit seven seg display and a hex keypad as well as all the vital bits that hang all these together. It is available as a kit but for anyone lacking the requisite confidence in their constructional abilities ready-built ELFs (or ELVES?) can also be supplied. I didn't build the machine reviewed but can see no practical problems in locating and soldering the components at their marked positions on the double sided, through plated PCB if the step-by-step instructions are followed systematically and the normal precautions taken to avoid blowing the CMOS chips by discharging static through them.

Having sorted out the hardware and laid on the 8V unregulated supply it's time to consider programming. At this stage machine code is all there is and a little work is required to get the hang of this at the first encounter. On the minimal ELF II there is no monitor (that comes a little later) and the three switches to the right of the hex keypad are used in various combinations to enter, examine and run programs and zero the stack pointer. Tom Pittman's short course in programming, specially written for RCA1802 based systems and, I suspect, for the ELF II in particular initiates the user in the meaning and use of all the instructions in the 1802's vocabulary with example programs at each stage. Later programs use a VHF modulator and TV set.

The CPU board has no monitor and as programs get longer and more sophisticated this becomes more of a disadvantage. Also the only way of entering programs on the CPU board is from the keypad. These two problems can be solved at a stroke using the "Giant" board. This provides I/O and a monitor. (The Giant board is also available built or as a kit with full instructions).

The connection to the CPU board is via an edge connector mounted on the left of the board. Although I have some reservations about this connection as no mechanical support is given to the vertically mounted "Giant" board it gave no trouble.

The monitor resides in ROM at memory location F000 and is entered by using an unconditional long jump to this location. Once the monitor is entered six operating modes are available and are selected using the codes 00 to 05.

- 00 runs a program from a specified two byte location.
- 01 allows the contents of any specified location to be displayed on the dual seven segment display. While the input key is held depressed the low order byte of the address is displayed and as the key is released the contents of the location are displayed. By pressing and releasing the input key the memory can be stepped through and a check kept on the address of the memory being displayed.
- 02 is similar to 01 but the contents of a specified location can be altered as well as inspected. The same method of displaying the address is used.

ELF REVIEW

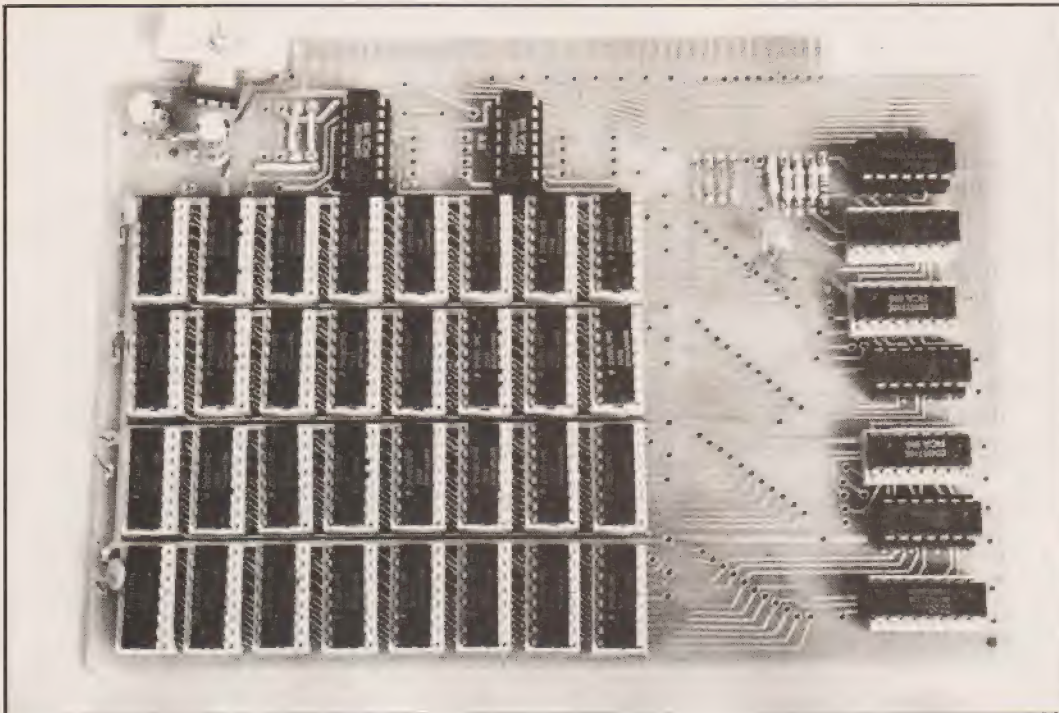


Fig.1. (far left) The Elf showing "Giant" board and 4K RAM expansion in sockets.

Fig.2. (left) 4K RAM board. The voltage regulator at top left gets hot enough to fry eggs on — definitely one to miss with the fingers.

INSTRUCTION SUMMARY

MNEM	NAME	OPCODE	PAGE			
ADC —	Add with Carry	74	42	LDN r	Load D via N 1<r<F	Or 35
ADC1 b	Add with Carry Immediate	7C bb	42	LUX —	Load D via R(X)	F0 35
ADD —	Add	F4	41	LDXA —	Load D via R(X)Advance	72 35
ADI b	Add Immediate	FC bb	42	LSDF —	Long Skip if DF is 1	CF 42
AND —	Logical AND	F2	39	LSIE —	Long Skip if Interrupts are Enabled	CC 53
ANI b	AND Immediate	FA bb	40	LSKP —	Long Skip	C8 22
B1 a	Branch on External Flag 1	34 aa	16	LSNF —	Long Skip if DF is 0	C7 42
B2 a	Branch on External Flag 2	35 aa	16	LSNQ —	Long Skip if Q is off	C5 25
B3 a	Branch on External Flag 3	36 aa	16	LSNZ —	Long Skip if Not Zero	C6 24
B4 a	Branch on External Flag 4	37 aa	16	LSQ —	Long Skip if Q is on	CD 25
BDF a	Branch if DF is 1	33 aa	41	LSZ —	Long Skip if Zero	CE 24
BN1 a	Branch on Not External Flag 1	3C a7	17	MARK —	Save X & P	79 55
BN2 a	Branch on Not External Flag 2	3D aa	17	NOP —	No Operation	C4 22
BN3 a	Branch on Not External Flag 3	3E aa	17	OR —	Logical OR	F1 38
BN4 a	Branch on Not External Flag 4	3F aa	17	ORI b	OR Immediate	F9 bb 39
BNF a	Branch if DF is 0	38 aa	42	OUT p	Output from memory; 1<p<7	6p 20
BNQ a	Branch if Q is off	39 aa	25	PHI r	Put D into High byte of register	Br 29
BNZ a	Branch on Not Zero	3A aa	23	PLO r	Put into Low byte of register	Ar 29
BQ a	Branch if Q is on	31 aa	25	REQ —	Reset Q	7A 15
BR a	Branch unconditionally	30 aa	18	RET —	RETurn	70 53
BZ a	Branch on Zero	32 aa	23	SAV —	SAVE T	78 56
DEC r	Decrement register	2r	27	SD —	Subtract D from memory	F5 43
DIS —	Return & DISable interrupts	71	53	SDB —	Subtract D from memory with Borrow	75 46
GHI r	Get High byte of register	9r	29	SDBI b	Subtract D from Immediate byte with Borrow	7D bb 46
GLO r	Get LOW byte of register	8r	29	SDI b	Subtract D from Immediate byte	FD bb 44
IDL —	Idle	00	14	SEP r	SEt P	Dr 52
INC r	Increment register	1r	27	SEQ —	SEt Q	7B 14
INP p	Input to memory & D; 9<p<F	6p	20	SHL —	SHift D Left	FE 47
IRX —	Increment R(X)	60	35	SHLC —	SHift D Left with Carry	7E 47
LBDF aa	Long Branch if DF is 1	C3 aaaa	42	SHR —	SHift D Right	F6 48
LBNF aa	Long Branch if DF is 0	CB aaaa	42	SHRC —	SHift D Right with Carry	76 48
LBNQ aa	Long Branch if Q is off	C9 aaaa	24	SKP —	Skip one byte	38 22
LBNZ aa	Long Branch if Not Zero	CA aaaa	23	SM —	Subtract Memory byte from D	F7 46
LBQ aa	Long Branch if Q is on	C1 aaaa	24	SMB —	Subtract Memory byte from d with Borrow	77 46
LBR aa	Long Branch unconditionally	C0 aaaa	18	SMBI b	Subtract Immediate Memory from D with Borrow	7F bb 46
LBZ aa	Long Branch if Zero	C2 aaaa	23	SMBI b	Subtract Immediate Memory from D	FF bb 46
LDA r	Load D & Advance	4r	34	STR r	SToRe D into memory	5r 32
LDI b	Load D Immediate	F8 bb	31	STXD —	STore D via R(X) & Decrement	73 33
				XOR —	EXclusive OR	F3 39
				XRI b	EXclusive OR Immediate	FB bb 40

- 03 writes to cassette the contents of any section of memory between any two specified two byte locations. When the machine is writing the Q led to the right of the display is lit.
- 04 reads from cassette, storing the program between two specified two byte locations. The rate at which information is read in is about 100 bytes per second.
- 05 scans the memory looking for a specified byte and when found gives the low order byte of its address.

Most cassette players will be found suitable as long as there is some means of getting a signal into a microphone input and out of an extension speaker output. The ELF I was loaned had a LED indicator and a decoupling arrangement on the tape input port. Software is available on cassette and I'll mention that I tried later.

Another function of the Giant board is to provide various other I/O formats. These are jumper selected and include 8 bit parallel in, 8 bit parallel out, TTY/2mA and R5232 all of which can be implemented without additional buffering. Full details are provided in the assembly instructions.

Before mentioning any more add-ons it will be worthwhile considering the 4K RAM cards up to 4 of which can be accommodated on edge correctors on the main board as is the Giant board. The only problem I found was with the voltage regulator which got very hot but even after about 12 hours of continuous use showed no sign of failing.

Sooner or later some means of examining more than one location at a time is an advantage and Elf-bug monitor on tape enables 24 locations to be displayed on a TV using a UHF modulator. The commands used by the Elf-bug are parallel to those used by the monitor and although the cassette read/write commands cannot be dealt with under Elf-bug they are passed on to the giant board monitor for execution. Also displayed using Elf-bug are the values in the registers. These appear each time Elf-bug is restarted.

This just about covers using the Elf II for machine code programming but it's capabilities don't end here. Although I didn't have a chance to try it I understand that there is an Assembler available on tape so I'll move on to the Elf II and BASIC.

Tiny BASIC on tape is available for the ELF and to use it an ASCII keyboard is required. Newtronics supply one for the Elf which has an excellent feel. Alternatively the new Newtronics terminal can be used and as this is what I had I'll restrict the description to this.

The VDU board used has all the usual alphanumerics but the graphics are sacrificed in favour of Greek letters. The output to a monitor can be set to 64 x 16 and to a TV 32 x 16. The BASIC is a little limited but I understand an extended version is being worked on. The only real complaint I had was that I found it impossible to POKE characters to the screen — a useful facility when writing games programs particularly.

The Elf II then is not the machine for anyone who wants to take it home, plug it in and run BASIC programs — there are much cheaper machines with better BASIC. The real appeal of the Elf is that building it up in easy stages gives a good insight into how both the hardware and software works, and so far control applications, development work and education and training purposes the Elf II is well worth considering.

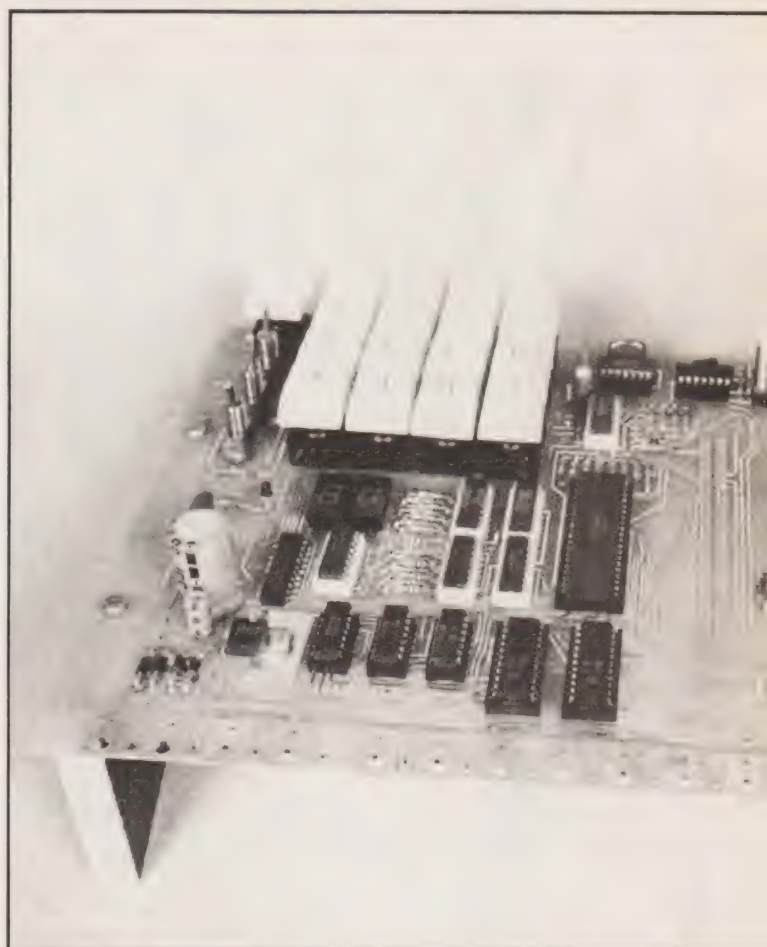
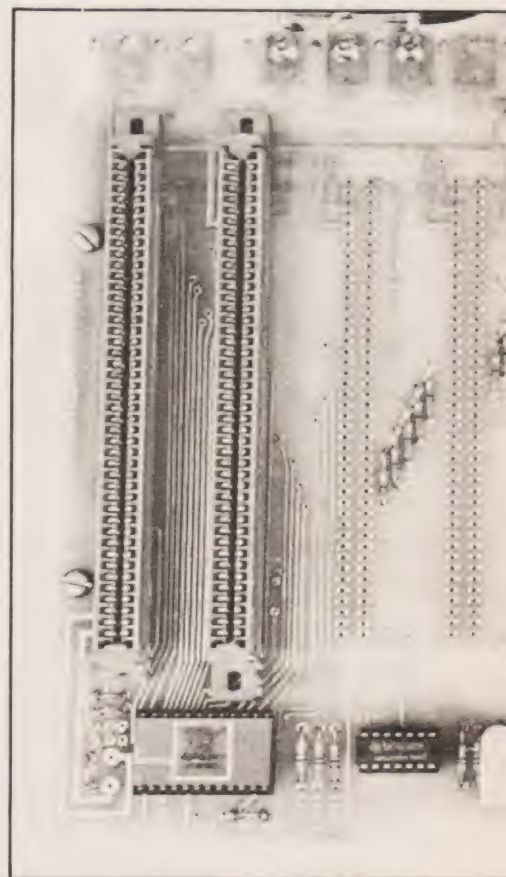


Fig.4 (right). The minimal system — a processor board, hex keypad and 2 digit 7 segment display. Only two of the five possible edge connectors are fitted here.



ELF REVIEW

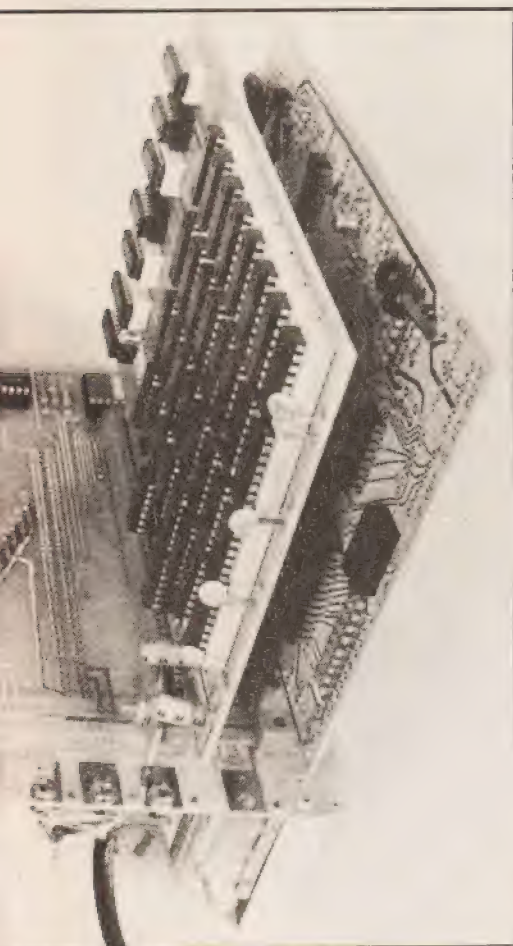
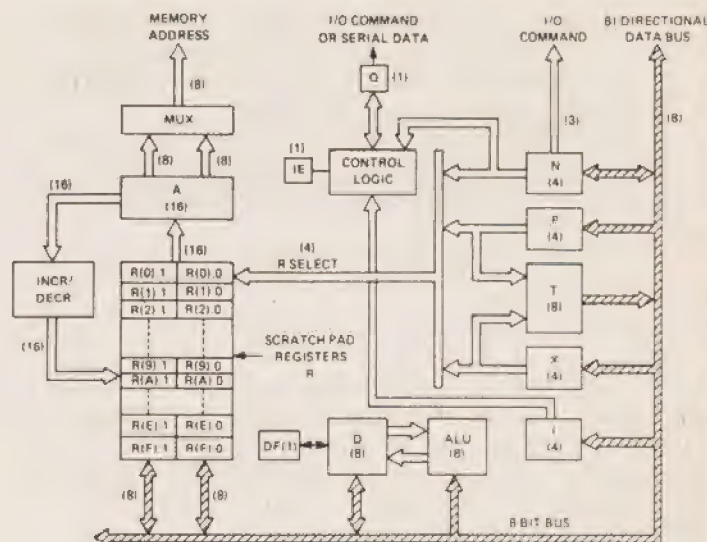


Fig.3 (left) The back view. Note cassette decoupling circuit and cassette input LED.



```
.. PROGRAM 2.1  -- MEMORY CLEAR
```

```

0000 90  CLEAR GHI 0  .. REGISTER 0 HAS 0001
0001 AE      PLO 14  .. MAKE RE=0000
0002 BE      PHI 14
0003 EE      LOOP   SEX 14  .. EACH TIME, R14 IS -1
0004 73      STXD    .. D STILL HAS 00
0005 30      BR  LOOP .. GO BACK FOR ANOTHER
0006 03

```

```
.. PROGRAM 2.2 -- MEMORY SEQUENCER
```

```

0000 90  SEQ      GHI 0  .. THIS PART IS
0001 AE      PLO 14  ..  JUST LIKE CLEAR
0002 BE      PHI 14
0003 EE      LOOP    SEX 14
0004 8E      GLO 14  .. THIS IS ADDRESS VALUE
0005 73      STXD           .. SO DATA=ADDRESS
0006 30      BR  LOOP .. REPEAT UNTIL DONE
0007 03

```

```
.. PROGRAM 2.3  -- SLOW BLINK
```

```

0000 91      BLINK GHI 1  .. LOOK AT TIMER IN 1
0001 CE      LSZ      .. IS ZERO ONLY 1/256
0002 7A      REQ      .. IF NOT 00, Q OFF
0003 38      SKP
0004 7B      SEQ      .. WHILE ZERO, Q ON
0005 11      INC 1    .. BUMP COUNTER
0006 30      BR BLINK .. THEN REPEAT.
0007 00

```

Above some sample programs and a schematic from the documentation provided.

Thanks to NEWTRONICS of 138 Kingsland Road, London N1, the distributor of the Elf II in this country, for the loan of the machine.

electronics today

international

What to look for in the November issue: on sale October 5th

TECH TIPS SPECIAL

Tech Tips has always been one of the most popular features of ETI. We're certainly not short of contributions. We thought it was about time we gave Tech Tips the deluxe treatment it deserves. Next month we have an 8-page Tech Tips Special — 8 pages of your ingenious suggestions for circuit designs.

TV GAMES UNIT

Hooked on telly tennis or football? We've been carrying out some in-depth testing of (playing with) a TV games unit for you to build.

You can play pin-ball, break-out and solo target basketball. The target basketball game is particularly difficult as you not only have to stop the ball falling off the bottom of the screen, but also press a button to shoot it up towards the target at the same instant as it hits your bat.

Break-out proved to be the star of the system. You gradually knock bricks out of the wall until your ball breaks through and hits the rear wall. It bounces back at break-neck speed and — shock, horror — your bat has shrunk to half size. If you manage to clear the screen, another wall springs up.

The sneaky part is that when you reset the unit, the last score is also displayed on the screen along with your current score. So, of course you have to beat your last score — even if you have to play all night. It's addictive.



GOT A LEAKY MICROWAVE OVEN?

You don't know, do you. If you use a microwave oven a lot, you'll naturally want to know how much radiation is leaking out to your kitchen. If you glow in the dark, you've got a good idea already.

To put your mind at rest, build our microwave oven leak detector. It couldn't be simpler.



KEEP YOUR ROLLING STOCK UNDER CONTROL

We present the ultimate in train controllers. Need something to do on the long winter nights? Do your train set proud with the latest miracle from our design team's secret development lab. — somewhere in Charing Cross Road.

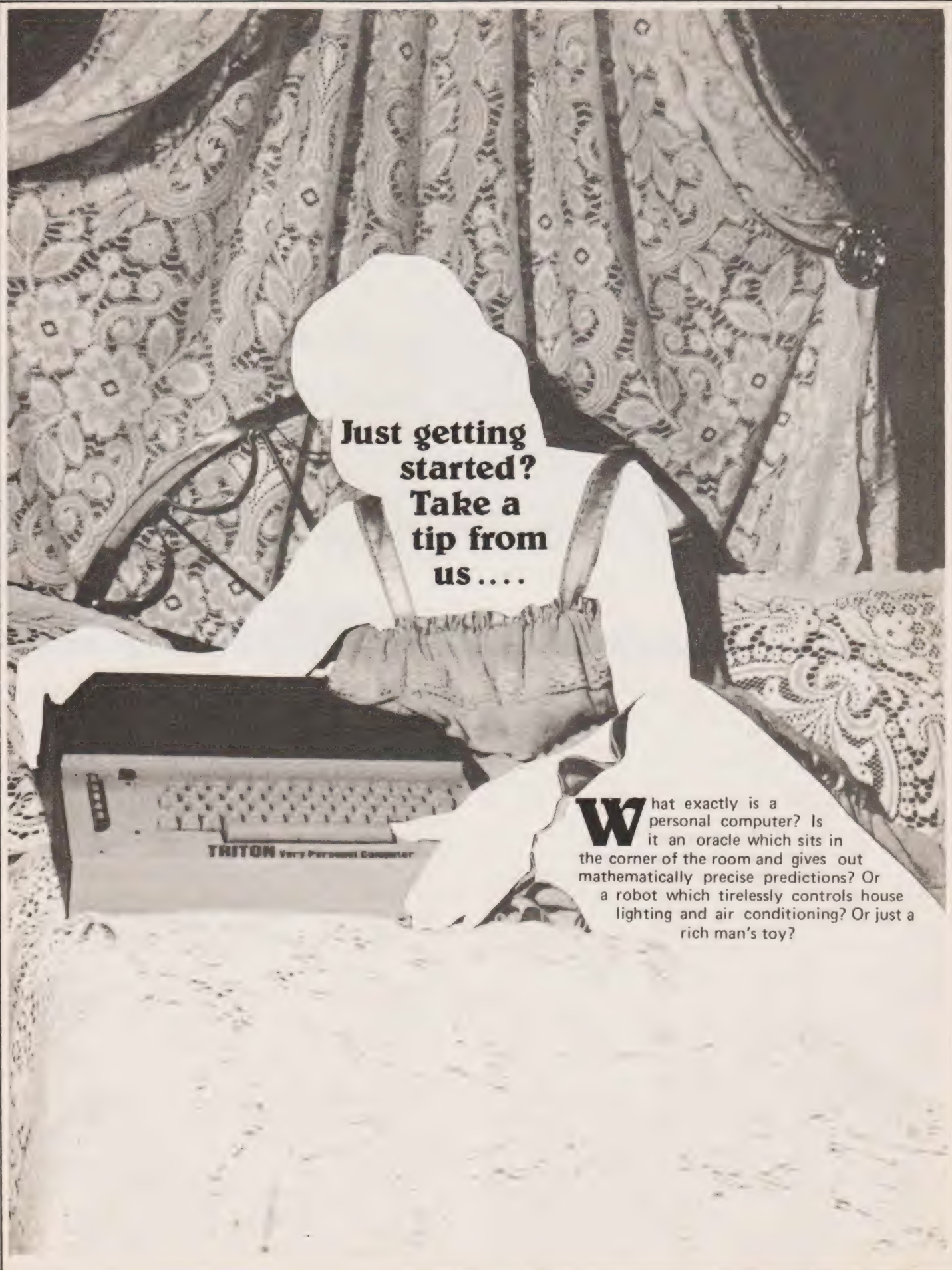
The central control unit gives you exceptionally fine speed control without the overheating problems you can expect from inferior designs. There's a built-in track cleaner to strip nasty oxides from the track and you can choose either conventional or push-button control.

OK, so now you've got the train trundling along on gleaming rails, but how do you tell it where to go? A capacitor discharge unit allows you to control up to 16 sets of points or relays.

If you prefer to put your feet up while bringing the 8.10 to a graceful halt, there's even a two-wire hand controller that lets you control four complete systems (tracks) and shows you which set of points is selected for switching.

Full details of this major model railway project will be in the November issue of ETI.

BUYERS GUIDE



**Just getting
started?
Take a
tip from
us**

What exactly is a personal computer? Is it an oracle which sits in the corner of the room and gives out mathematically precise predictions? Or a robot which tirelessly controls house lighting and air conditioning? Or just a rich man's toy?



The CompuColor home computer with its integral disk and separate keyboard. Although brilliantly documented the hardware design is slightly suspect. The colour graphics are very easy to use.

The hobby computer market has split into two clearly-defined areas: The first is exemplified by products such as the Commodore PET, the Exidy Sorcerer and the Tandy TRS-80. This is the "easy-to-use, plug-in-and-go" high end of the market. Applications. Teaching the buyer how to use a computer, working as a calculator, figuring bank balances and astrological charts, playing 'sophisticated' computer games.

The other half of the market is the get-you-started systems (usually sold as kits) which don't do anything useful as they stand but are very much more instructive. Products which fall into this area are too diverse to mention, as the capital needed to begin production of these devices is much smaller than that required to produce a larger unit. They can't immediately be used as calculators and to do anything with them except learn, you have to have a fairly high level of knowledge — which you can get by buying one and studying.

The eventual application of one of these smaller systems is, however, more interesting than the complex calculator type mentioned earlier. Due to the level of knowledge the smaller systems offer, the possibilities depend only on the ability of the user. You can turn one into a calculator type system if you want to. You can also use it to control air conditioning or vacuum the floor or even tell you jokes.

The high price systems can, of course, be used for 'control applications' (house lighting, etc.) but they are more difficult to modify for this purpose and the user would presumably be happier modifying something he paid £200 for and built himself than something for which he paid £1000 and has never seen the inside of.

Up-market Machines

What do we mean by an 'up-market' personal computer? Essentially, it's one that can work out $2 + 2 = 4$ as soon as you plug it in. It's a super-calculator. It's (usually) programmed in BASIC (Beginner's All-purpose Symbolic Instruction Code).

Fine. What do you do once you've got it out of the packing case?

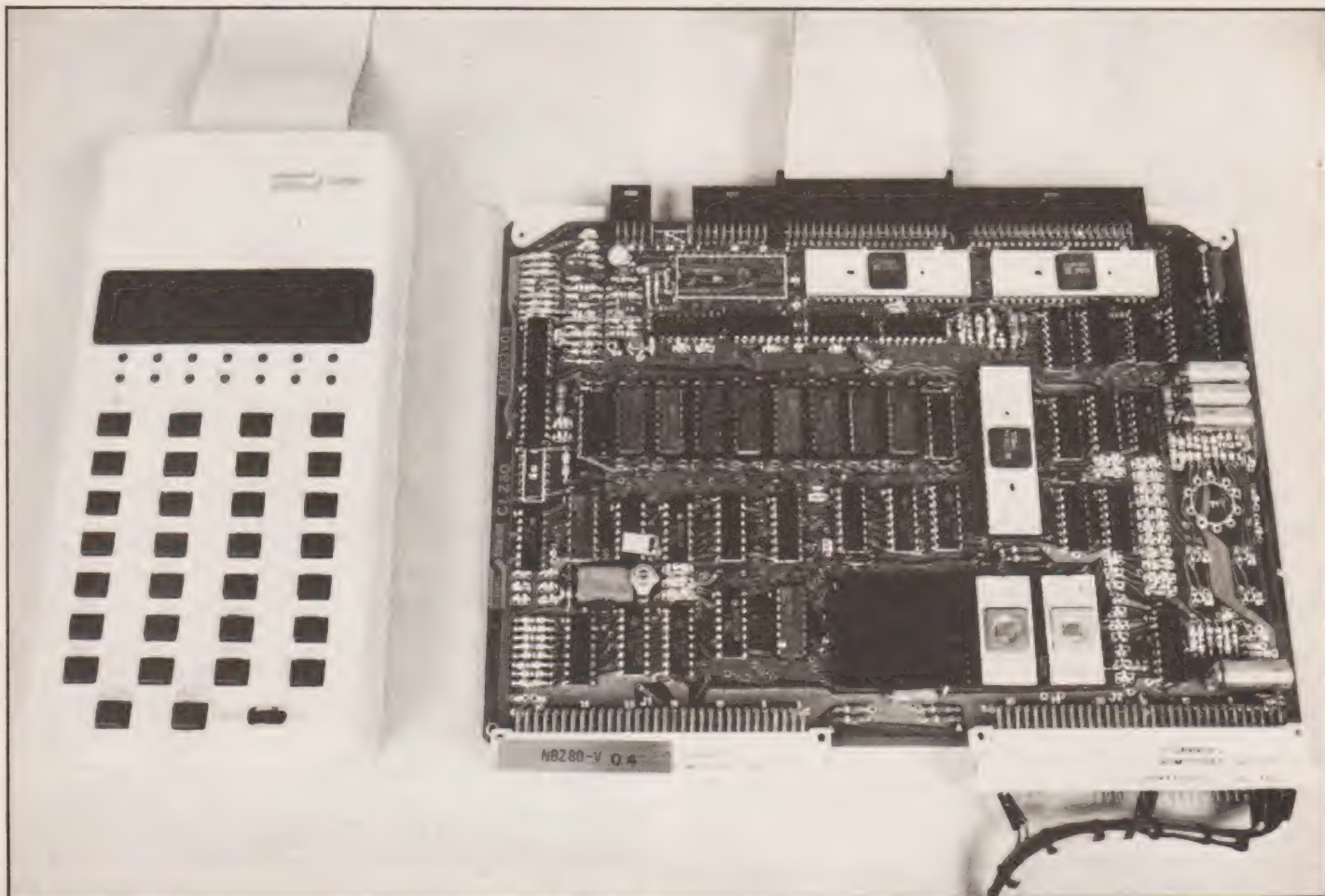
First, you plug it in to a wall socket. This is usually all the wiring up you have to do. Let's take the example of the Commodore PET. The PET has a Video Display Unit (VDU) (which looks just like a TV screen, except that it displays words instead of pictures) built into the top of it. You switch it on, type in "? 2 + 2", and the PET will display on its screen:

? 2+2
4

showing that the answer is 4.

What if you want to program it? There is a comprehensive guide with the machine which tells you how to go about this. A program is a sequence of instructions which you want the machine to carry out. Once you have entered them, the computer will do them in sequence on request — just like a programmable calculator. If, however, you turn the machine off, it will forget the program that is holding at present. This is pretty useless if it's a program which you want to use again and again, and so the PET has the facility

BUYERS GUIDE



A basic Nanocomputer system. Superb design allows the educational system to be expanded to a full Z80 based computer with all the standard facilities.

of recording any given program onto a cassette using an inbuilt cassette recorder. You simply insert a perfectly normal audio cassette and type in the word "SAVE". The PET will record the program onto the tape. You take the tape out, turn the machine off and the next time you want to use that particular program, you put the tape back in and type "LOAD". The PET will play the tape and remind itself of the program which you had it store earlier.

Now let's look at the Exidy Sorcerer. Although the Sorcerer is a more powerful machine (i.e. it can do more things in a shorter amount of time than the PET can) it doesn't have a built-in VDU and cassette deck. Is this a problem? Not at all. You simply connect the aerial socket of your TV set to the back of the Sorcerer and behold! it becomes the VDU. Similarly, when you want to save a program, you connect it to your cassette deck (the one you've just recorded "ABBA" on) and away you go. The Sorcerer is also programmed in BASIC (although it has the facility to change languages when Exidy, the manufacturers, get around to producing the firmware) and also comes complete with a full instruction manual on how to go about writing a program.

A machine very similar to the Sorcerer is the Sord M-100. The major difference is that it has an S-100 output built in (see later) and two analogue inputs for connecting it to... well, anything you can think of!

The Apple offers much the same facilities as the

Sorcerer, except that if you happen to have a colour TV set to plug into the back, it will allow you to have letters and words in different colours — for example, if you have written a program to tell you when your biorhythms are at their worst, you can arrange to have the words "take care!" flashed on the screen in bright red whenever you are about to go through a bad patch.

The Tandy TRS-80 is also much the same in its basic structure as the Sorcerer, except that Tandy supply a specially-designed cassette recorder and cut-down TV set to go with it as part of the package.

What's The Difference

Right about now, you should be asking yourself the question, "What's the difference between all these systems, apart from the prices?". In order to answer that one, we'll split the facilities offered into several areas:

- 1) VDU
- 2) Tape recording
- 3) Keyboard
- 4) BASIC
- 5) Inputs and Outputs

First, the VDU. The only special feature in a VDU is whether it's colour or black and white.

Tape recording is very simply dealt with as well — they either have it built in, supplied or external (ie: you use your own). In terms of reliability of recording, there's not much difference, although in the past PET has come in for a good deal of criticism Commodore now seem to have solved most of the problems. The main reason is that audio and data recording are not the same, data is much more critical, you

can't lose bits without upsetting the computer — the human ear is much more tolerant.

The keyboard is really only an important consideration if you can type. If you can't, there's very little to choose between the makes mentioned above. If you can, the PET is going to be a bit slower to use than the rest as it has very small keys. However Commodore are now producing the larger PETs with a proper typewriter keyboard, once again customer feedback has produced a design change in the original machine.

BASIC, the language in which all of the above machines are programmed comes in many different shapes and sizes. Some are easy to use and very powerful (ie: fast) and some are not so easy, others not so fast. The particular brand of BASIC used in the PET is written by a Californian firm called Microsoft and is very easy to use and reasonably fast. Some machines such as the Apple and Sorcerer are in the process of being equipped with other languages such as Pascal but it should be noted that all these machines have the capability of being programmed in machine code.

The Sorcerer's BASIC is essentially the same as the PET's but with a few little add-ons. The Apple and TRS-80 BASIC are also about the same as the PET's.

What it all boils down to is that Apple users will swear blind that the Apple version is streets ahead of the rest and similarly any PET user will go blue shouting that the PET's version is the best and so on...

If at some time in the future, after you have completely mastered your up-market machine (which takes about six months on average) you may want to add a few things to it, such as a printer, a floppy disc or even something to control your air conditioning. All these need I/O. I/O is a lazy way of saying Inputs and Outputs.

The PET has a particularly obscure I/O scheme, using what is called the IEEE 488 bus. No other personal computer on the market (that we know of) uses this scheme, some desktop computers, notably Hewlett Packard, use the system however so you can use the PET for instrumentation work. Luckily the PET has become so popular in the States and



Europe that it's worthwhile for people other than Commodore to produce add-on bits which will convert the PET to S-100.

S-100 is an almost universal I/O scheme. Printer, floppy discs and even voice recognition units are readily available which will plug straight into anything which uses

MICROPROCESSORS

WHAT'S THE DIFFERENCE BETWEEN THEM?

The most commonly used microprocessor chips in the hobby market are the 8080, Z-80, 2650, SC/MP and 6502. Other variants can be easily spotted — the 8085 is very similar to the 8080 but with certain changes. The Z-8000, newly arrived on our shores is a 16 bit machine, that means it's more accurate, but as yet it has not been implemented on any system.

This is a difficult question — it's like high-level languages (of which there are many different types and variants), people who are used to a particular one will prefer it to any other. Long arguments develop between programmers over the good and bad points of each language. It's the same way with processors.

The 8080 is probably the processor with the most 'software support' — it has the most programs written for it. The Z-80 can run any program written for the 8080, as well as some which the 8080 cannot.

The SC/MP has the advantage that it needs practically no 'support chips' — it will more or less stand alone

and is thus ideal for many 'dedicated' applications, such as doorbells, alarms, etc.

The major differences between the processors in terms of programming are the instruction sets and the number of registers.

The instruction set of a processor is a list of all of the different arithmetic and logical operations it can perform — like the number of keys on a calculator. The registers in the processors are the same as calculator memories — the more, the better.

The 8080 instruction set is about the same level of complexity as the 2650 and the 6502. This is adequate for most applications.

The SC/MP has a rather limited instruction set and relies on it's ease of application for its appeal.

The Z-80 instruction set includes the 8080 set — and then some! It also has twice the number of registers. In general, though, it is usually felt that the 8080 level of complexity is sufficient for the beginner.

BUYERS GUIDE



Above: A cased version of TECS, the BASIC/Teletext and Prestel system. It could turn your living room into a data base as it is a fully intelligent terminal, based on a 6800.

Left: The familiar Apple II colour graphics computer with an add-on disk. Much software and hardware support is available.

the S-100 bus system.

The Sorcerer has a system called the RS-232. This is a rather old fashioned I/O system which was used with teletype machines. It also has a more sophisticated system for which S-100 adaptors are available.

Both the Apple and the TRS-80 have their own

systems, with S-100 adaptors being available for either.

Commodore have only recently produced add-ons for their machine, as have Exidy but because of the delay in production many companies have started to produce hardware for the popular machines to fill these gaps. With S-100 type systems however a vast range of second source hardware exists to satisfy user needs. Manufacturers like Tandy and Apple have produced add-ons for their machines, printers and disks mainly.

Cheaper Alternatives

The 'Up-Market' systems mentioned above will cost you hundreds of pounds each. What about something cheaper?

For some time there have been units on the market which are described as 'evaluation kits', intended for use by industrial concerns who are wondering whether to use a particular microprocessor or an alternative one. These kits have evolved into the 'single-board' devices available to amateurs at very low prices today.

They usually consist of a single printed circuit board, carrying all of the devices necessary to teach the user just what is going on inside a computer.

They carry a set of keys which enable you to input Hex digits and a number of 'control keys', such as 'RUN', 'DELETE' and the like.

Most of these units come with their own power supplies, so that all you have to do is to plug them in. Most of them also come with fairly good instruction manuals, although there are one or two which are not so good. Try to get a look at the instruction manual before you buy — in some cases it's a more important consideration than the unit itself.

A good instruction booklet will usually begin with something you can understand and will continue with something you can understand after you've read the first bit.

A poor instruction booklet will begin with something which you can understand and then continue with something which is totally foreign to you.

BUS SYSTEMS

S-100 AND ALL THAT

What exactly is the S-100 bus? Or any bus for that matter? No, they're nothing to do with public transport. The word 'bus' is short for 'omnibus' (literally: 'for all'). Basically, it's a method of interconnecting parts of a computer system so that they can communicate with each other.

It takes the form of a 'backplane' or 'mother board' which holds several edge connectors. Printed circuit boards can be plugged into these, one edge of the board being covered in gold-plated strips right up to its edge. Contacts on the edge connector make electrical contact with these strips. The S-100 bus system uses double-sided boards with 50 strips per side (thus the 100 in S-100!).

Each board — one of which will be the microprocessor board, holding the micro chip itself plus all the other 'support' chips necessary to get the thing to work, such as oscillators and buffers etc — has some outputs and some inputs which are connected to the bus in a standard

configuration. There are sixteen lines of the bus which carry information on 'addresses'. This is how a position in memory is defined — by a sixteen digit binary number. When the microprocessor wants to find out what's at a particular address on the board which carries the memory, it puts that address on the sixteen address lines, puts out a request on some of the other lines of the bus and the memory board looks up the required information and puts it onto the 'data' section of the bus. The microprocessor board then reads the data from the bus.

Other buses have differing numbers of lines and the positions of the data and address lines are also different but they work in essentially the same manner. Unfortunately, it is difficult to connect a board intended for one bus system to a board intended for another. For this reason, each manufacturer either uses his own bus structure, or sees the light and uses the S-100, which is about as close to a standard as the hobby computer field has.

What Can You Do?

These evaluation kits are basically for education only. In order to do anything useful with them (such as add $2 + 2$), you have to know how to use them and programming the problem almost always takes longer than working out the answer on paper. However for some reason the UK hobbyist seems to have made these evaluation systems do far more than you would expect. The Nascom is very popular and also expandable, Acorn seems to be headed the same way and the faithful MK14 has had more added to it than most people realize.

The output will usually not be via a VDU although there are some exceptions in which there is a TV output similar to the one on the Sorcerer or Apple.

A more usual form of output though is a number of calculator-like digits (called seven-segment displays). These can indicate the numbers and letters 0 to 9 and A to F necessary to display Hex digits.

The sort of thing you can do with the unit as it stands is to look at a specific memory location (or pigeon-hole, of those of you who learned about computers at school) to see what's in it. This is exactly the same as displaying the contents of one of the calculator's memories, except that each location will only hold (usually) two hex digits. So you enter (via the keyboard) A56B, which is the number of the location you want to look at. You then press the 'MEM' button, or whatever it's called on the particular model you have bought, and the display shows A56B 6F, which indicates that the value stored in 'pigeon hole' A56B is 6F. This won't mean much to you until you realise that A56B is the location which stores, say, the result of an addition which the machine has just carried out and that 6F is equivalent to 111 in decimal that is! Then the information becomes a bit more interesting.

In fact, the whole thing becomes fascinating once you get into it.

Once you have completely mastered this sort of unit (and that takes a lot more time than it takes to master the more up-market all-singing, all-dancing units) then you reach a bit of a problem. The problem is, do you expand your system with extra memory and facilities which inevitably

means a rather untidy system or do you scrap the lot and buy a single unit machine such as PET.

Although you may have spent over a hundred pounds on the unit, you have gained well over that in education. You can now decide whether to graduate to a more flexible system, and sell your system to another beginner or carry on.

S-100 Systems

Remember S-100? Earlier in the article we mentioned it as a standard for interconnection of peripherals (add-ons such as printers, disc drives and the like) to large hobby computers.

Suppose you buy a get-you-started unit with S-100 connections on the bottom of it. These take the form of 100 'edge connections' which allow you to plug the board directly into a dirty great socket.

This socket is connected, pin for pin, with several other such sockets, all mounted on a printed circuit board called a backplane or motherboard.

Other S-100 boards, containing extra memory, or the electronics necessary to connect to a printer, or a voice synthesis board, or a TV display, (or whatever you want) can be plugged into the motherboard and are connected automatically with the main board, which carries the micro-processor.

Why not start with an S-100 system if you'll want one eventually anyway? The answer is the price (isn't it always?).

A complete S-100 system — complete enough to start computing on — will cost you just less than a large hobby computer. It's also much more difficult to get going. Some people have started on S-100 and got off the ground, but it's difficult (at the moment).

Summary

Computing is just like hi-fi. What you buy depends on how much time and money you want to spend and how enthusiastic you are (which is not always the same thing). What ever you do buy, you can rest assured that if you stick at it you will not only gain a very valuable tool, you'll have a lot of fun doing it.



Above: The ubiquitous PET with Commodore's own printer and dual disks. Right: Rair's "Black Box" system, it costs more but does a lot more including having a wide variety of languages available.



BUYERS GUIDE

COMPLETE SYSTEMS

Name PET
Supplier: Commodore Systems, 360 Euston Road, London.
Telephone: 01-388 5702
CPU: 6502
Standard system: RAM 4-32K ROM 14K
 I/O IEEE-488
 Tape Internal
Keys: Full ASCII
Expansion: RAM Yes ROM Yes
 Etc. Printers, disks, extra cassette, I/O.
Languages: BASIC
Price: from £460
Reviewed: April '78 ETI
Notes: The original single unit home computer, expansion from a wide variety of sources.

Name TRS 80
Supplier: Tandy Corporation, Bilston Road, Wednesbury, West Midlands.
Telephone: 021-556 6101
CPU: Z80
Standard system: RAM 4K ROM 4K
 I/O RS232 Tape Yes
Keys: Full ASCII
Expansion: RAM Yes ROM Yes
 Etc. Printer, disk
Languages: BASIC in various versions
Price: from £500
Reviewed: ETI August '78, April '79
Notes: An expandable complete system available in two versions for home and office use.

Name Apple II
Supplier: Keen Computers, 5 The Poultry, Nottingham + others.
Telephone: 0602-583254
CPU: 6502
Standard system: RAM 16K ROM 8K
 I/O Various options
 Tape Yes
Keys: Full ASCII
Expansion: RAM Yes ROM Yes
 Etc. Disks, printer, speech synthesiser.
Languages: BASIC, Pascal
Price: £830
Reviewed: April '79
Notes: A cased, expandable colour graphics system with wide support.

Name: Sorcerer
Supplier: Factor One, 11-17, Market Place, Penzance, Cornwall.
Telephone: 0736-66326
CPU: Z80
Standard system: RAM 8K ROM 4K
 I/O Parallel Tape Yes
Keys: Full ASCII
Expansion: RAM Yes ROM
 Etc. S100 expansion, printer, VDU, plug-in software, I/O
Languages: BASIC, (APL, Fortran and Pascal soon)
Price: from £700
Reviewed: Supplement 4
Notes: Self contained home computer with good graphics.

Name TECS
Supplier: Technalogs, 8 Egerton Street, Liverpool.
Telephone: 051-724 2695
CPU: 6800
Standard system: RAM 4K ROM 4K
 I/O Parallel + RS232
 Tape KANSAS
Keys: Full ASCII + TV control
Expansion: RAM Yes ROM Yes
 Etc. Disk, printer, Prestel, I/O, case.
Languages: BASIC, Assembler, Pascal
Price: from £390
Reviewed: May '79
Notes: Can be used as a full intelligent Prestel terminal, Teletext is standard.

Name Compucolor
Supplier: Abacus Computers Ltd., 62 New Cavendish Street, London W1M 7LD
Telephone: 01 580 8841
CPU: 8080
Standard system: RAM 8K ROM 16K
 I/O RS232 Tape DISK
Keys: Full ASCII + graphics control
Expansion: RAM Yes ROM
 Etc.
Languages: BASIC
Price: £1390, includes monitor and disk
Reviewed: June '79
Notes: Colour graphics system with inbuilt monitor and disk.

Name 380Z
Supplier: Research Machines, PO Box 75, 209 Cowley Road, Oxford.
Telephone: 0865-49792
CPU: Z80A
Standard system: RAM 4K ROM 4K
 I/O RS232 + parallel
 Tape CUTS
Keys: Full ASCII
Expansion: RAM Yes ROM Yes
 Etc. Disks, printer, I/O, various TV monitors.
Languages: BASIC, Assembler, Fortran, Algol, Cobol.
Price: £1025 incl cassette and monitor.
Reviewed: April '79
Notes: Expandable cased system used in education and scientific fields.



BUYERS GUIDE

KITS AND SINGLE BOARD COMPUTERS

Name NASCOM 1
Supplier: Nascom Microcomputers, 92 Broad Street, Chesham, Bucks.
Telephone: 02405-75151
CPU: Z80
Standard system: RAM 2K ROM 1-2K
 I/O Parallel + RS232
 Tape Yes
Keys: Full ASCII
Expansion: RAM Yes ROM Yes
 Etc. Moter
 Etc. Motherboard, frame PROM blower, graphics, I/O boards
Languages: BASIC, Assembler, M5
Price: £178
Reviewed: Supplement 1, April '79
Notes: OEM expandable system.

Name Superboard II
Supplier: Lotus Sound, 4 Morgan Street, London E3 5AB + others.
Telephone: 01-981 3993
CPU: 6502
Standard system: RAM 4K ROM 10K
 I/O Parallel
 Tape KANSAS
Keys: Full ASCII
Expansion: RAM Yes ROM
 Etc. Case, Extended monitor
Languages: BASIC
Price: £188
Reviewed: July '79
Notes: Single board system with BASIC

Name AIM 65
Supplier: Pelco Electronics, Enterprise House, 83-85 Western Road, Hove, Sussex.
Telephone: 0273-722155
CPU: 6500
Standard system: RAM 2-4K ROM 8K-20K
 I/O RS232 + parallel
 Tape 2
Keys: Full ASCII + printer
Expansion: RAM Yes ROM
 Etc. Motherboard, case bubble memory.
Languages: Optional BASIC
Price: £250
Reviewed:
Notes: Single board system with integral printer.

Name ELF
Supplier: Newtronics, 138 Kingsland Road, London N1
Telephone: 01-739 1582
CPU: 1802
Standard system: RAM 256 byte ROM None
 I/O Tape No
Keys: Hex pad
Expansion: RAM Yes ROM Yes
 Etc. Motherboard, tape I/O, ASCII keyboard, VDU.
Languages: BASIC ontape
Price: from £79
Reviewed: October CT
Notes: 1802 development kit but expandable.

Name TRITON
Supplier: TransAm, 12 Chapel Street, London NW1 5DH
Telephone: 01-402 8137
CPU: 8080
Standard system: RAM 4K ROM 4K
 I/O Parallel + RS232
 Tape Yes
Keys: Full ASCII
Expansion: RAM Yes ROM Yes
 Etc. Motherboard, printer, PROM blower, various monitors.
Languages: Various BASIC's, Assembler.
Price: from £286
Reviewed: ETI Nov '78
Notes: Single board cased system in kit form but expandable in both hardware and firmware.

Name MK14
Supplier: Science of Cambridge, 6 Kings Parade, Cambridge.
Telephone: 0223-311488
CPU: SC/MP
Standard system: RAM 2566 byte ROM 512 byte
 I/O Parallel Tape
Keys: Hex pad
Expansion: RAM Yes ROM
 Etc. Tape, VDU, PROM blower
Languages: Machine code
Price: £47
Reviewed: ETI Sept '78
Notes: SC/MP evaluation system, a good starting point.

Name Nanocomputer
Supplier: Midwich Computer Company, Hillsborough House, Churchgate Street, Old Harlow, Essex.
Telephone: 0279-25756
CPU: Z80
Standard system: RAM 4-4K ROM 4K16K
 I/O Parallel + RS232
 Tape Yes
Keys: Hex terminal
Expansion: RAM Yes ROM Yes
 Etc. Disk, frame, Experiment kit.
Languages: BASIC, Assembler
Price: from £260
Reviewed: Aug '79
Notes: OEM system for education but fully expandable.

Name: Acorn
Supplier: Acorn Computers Ltd., 4A, Market Hill, Cambridge.
Telephone: 0223-312772
CPU: 6502
Standard system:— RAM 1K ROM ½K
 I/O Parallel Tape CUTS
Keys: Hex pad
Expansion:— RAM Yes ROM Yes
 Etc. VDU, disk, I/O
Languages: BASIC soon
Price: from £75
Reviewed: August '79
Notes: A 6502 evaluation kit of good design and suitable for wide expansion.

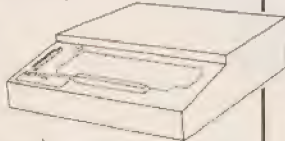
TRANSDAM

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TRITON

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- Cassette Interface

- Three Firmware options
- Basic in Eprom
- Plug-in Expansion Boards

Personal Computer

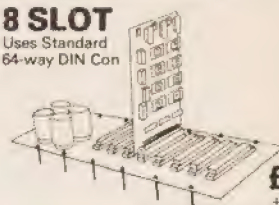
£286 + VAT
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TRITON. Expand your Triton simply and easily with our new 8-slot motherboard complete with its own P.S.U., takes 8 plug-in Euro cards. Plug-in 8K RAM card and Eprom cards now available. Kit complete with PSU + 1 set connectors.

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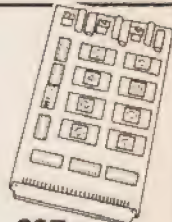
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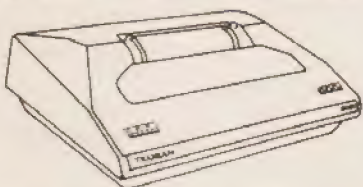
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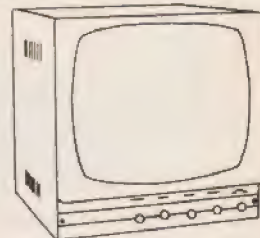
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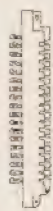
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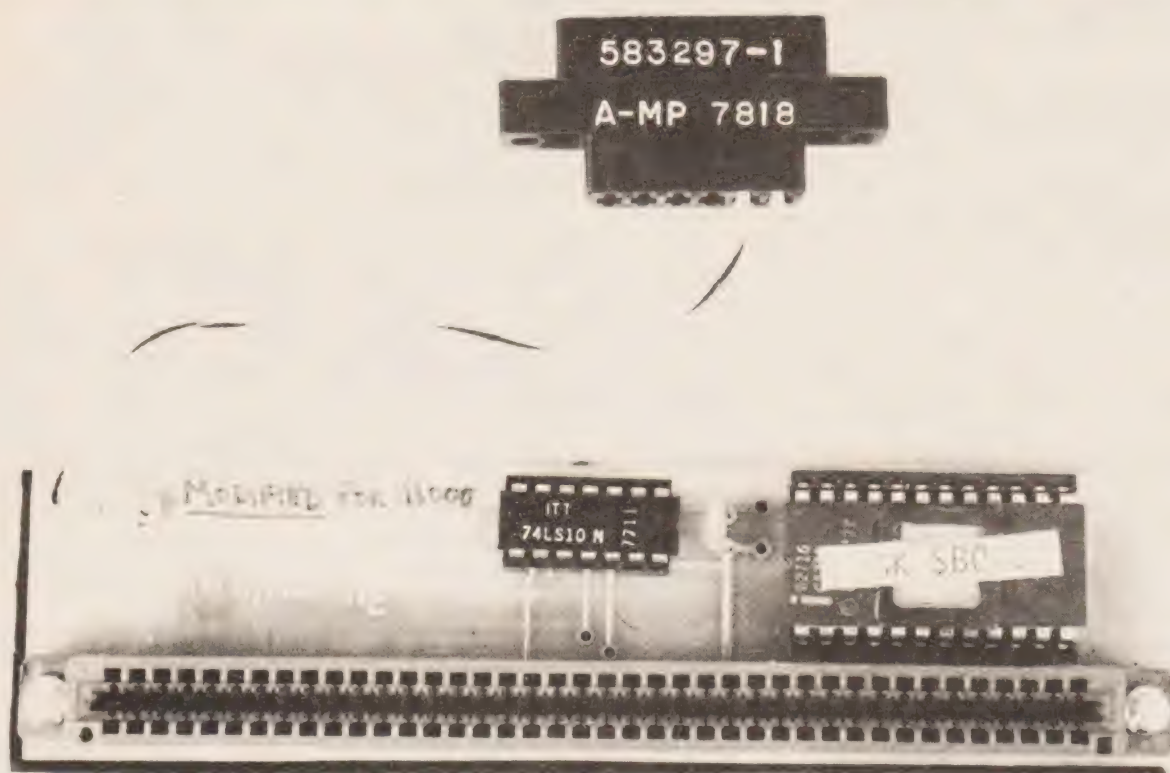
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Firmware magic for the PET

Once upon a time a home computer was designed. The company called it the PET and it became one of the best selling home computers in the world. However because of the lack of skilled programmers using PET mistakes were made, errors crept into programs and users got frustrated because they couldn't do simple things. If this sounds like a fairy tale to you and you are waiting for the happy ending — wait no longer.

Firmware Goes Faster

The new product which has changed the PET from a "dumb" system into a reasonably "intelligent" one is the Programmers Toolkit. It contains a set of machine code routines, their functions are listed in Table 1, which provide for the user a number of utility type commands.

The pre-production version that we were lent was designed for use on an old-ROM machine. As can be seen in the photograph it simply consists of the firmware ROM, an IC and an edge connector socket that plugs on to the memory expansion port. Power is supplied to the unit by the second plug that goes into the spare cassette interface. Fitting the unit took about 30 seconds and provided you remember to turn your machine off first no problems were encountered.

A second version of the Toolkit is available for new-ROM machines, this plugs directly into the spare left hand empty socket inside, again fitting should not be a problem.

Power On Power Up

Once fitted the new system is initialised by typing a single command SYS 45056, and the device echoes back the fact

that it is loaded. That's all there is to it really, you can use your PET as normal without even knowing you have something extra under the bonnet as it were.

What exactly do you get? Well to start with you can type your programs in without using line numbers. By use of the command AUTO X, Y (where X is the starting line and Y the interval between lines) your line numbers are automatically put on the screen for you each time you press RETURN. To end program input you have to type RETURN twice. Having written your program you will now wish to run it and this is where the real power of the Toolkit appears.

Debugging Software

The range of debugging aids is extensive, seven in all, and they allow you to correct virtually any mistake in your BASIC program. If we assume you have created a syntax error in the program when you try to run it all you get back is ?SYNTAX ERROR. Very helpful! Type HELP and the Toolkit returns the first line it finds with a syntax error and displays the offending character in reverse field so you can see it. Edit the line and carry on.

If you find, as we always do, that you have had to add a line or two in at a later date and you want to tidy up the program just type RENUMBER X, Y (where X and Y are as explained before) and the Toolkit does the rest, and very quickly too.

One of the really boring things about BASIC is you have to delete each line separately, with the Toolkit you can DELETE 100, 350 or any given numbers in one command.

To see just how or why your program is not working quite as you thought there are two other commands, TRACE and STEP. The TRACE command followed by RUN executes your program at about a tenth of the normal speed and always shows the last six line numbers of execution in the top right hand corner of the screen. This allows you to

PET TOOLKIT

check loops and subroutine jumps. You can stop and start the program at any point by use of the RUN/STOP key. The STEP command causes the PET to execute one command at a time by use of the SHIFT key, holding it down runs the program continuously at about one tenth normal speed. Both these commands can be turned off by the command OFF.

Two other commands are available for debugging purposes, DUMP which lists all variables and strings used in the program and FIND which allows you to list all occurrences of a specified character string, eg GOTO or AS\$ or FRED.

Last But Not Least

One final command is available on the system, APPEND. This is a command that allows you to add previously written bits of program to the one you are currently working on. All you do is type APPEND "filename" and then press PLAY on the cassette. When it finds the program on tape it appends it to the one in memory. All you have to do then is to tidy it up and carry on. Start your subroutine library now!

Conclusions

The device we have described above allows you to perform a number of useful functions on any BASIC program. Because it becomes part of your PET you don't lose any memory space, merely gain power. It will be marketed in this country by Petsoft from September at a cost of £75 for the plug on version or £55 for the single ROM. The device has Commodore approval for use with PET and we think that it is an exceptionally good piece of equipment. Try one at your local dealer and see if you are as impressed.

Table 1

COMMAND	Function
AUTO	Automatic line numbering, any start, any step
DELETE	Bulk deletion, any number to any number
RENUMBER	Automatic re-numbering, any start, any step
HELP	Returns error in reverse field
TRACE	Displays last six executed line numbers in top right of screen
STEP	Single step with SHIFT key, displays line numbers as TRACE
OFF	Turns off TRACE and STEP
APPEND	Builds programs from library tape
DUMP	Displays all variables and strings used
FIND	Displays all occurrences of a specified string or command etc.

Acknowledgement: We are most grateful to Julian Allason of Petsoft for letting us have one of the only two 'Toolkits' available at the time of writing this review.

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With respect and acknowledgement to Mr I Davidson, this is his Etch-A-Sketch program (Softspot May'79) modified to run on a standard Nascom 1 with a T2 monitor.

```

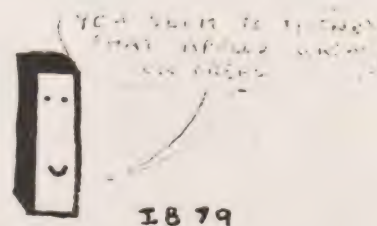
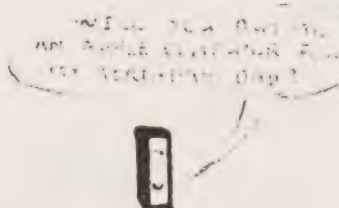
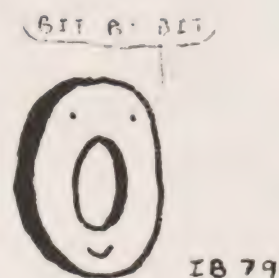
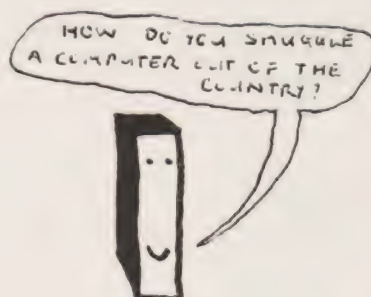
0C50 3E    CLEAR
0C51 1E    SCREEN
0C52 CD
0C53 3B
0C54 01
0C55 21    POINTER TO
0C56 E1    CENTER OF
0C57 09    SCREEN
0C58 CD    CALL CHIN
0C59 3E
0C5A 00
0C5B 47    LD B WITH A
0C5C 70    LD (HL) WITH B
0C5D CD    CALL CHIN
0C5E 3E
0C5E 00
0C60 FE    CP
0C61 52    'R'
0C62 CA    IF 'R' THEN
0C63 77    JP 0C77
0C64 0C
0C65 FE    CP
0C66 4C    'L'
0C67 CA    IF 'L' THEN
0C68 7B    JP 0C78
0C69 0C
0C6A FE    CP
0C6B 55    'U'
0C6C CA    IF 'U' THEN
0C6D 7F    JP 0C7F
0C6E 0C
0C6F FE    CP
0C70 44    'D'
0C71 CA    IF 'D' THEN
0C72 8A    JP 0C8A
0C73 0C
0C74 C3    IF NONE OF
0C75 5D    ABOVE BACK
0C76 0C    TO 0C5D
MOVE RIGHT
0C77 23    INC HL
0C78 C3    JP TO
0C79 5C    0C5C
0C7A 0C
MOVE LEFT
0C7B 2B    DEC HL
0C7C C3    JP TO
0C7D 5C    0C5C
0C7E 0C
MOVE UP
0C7F 97    CLEAR ACC
0C80 2B    DEC HL
0C81 3C    INC ACC

```

```

0C82 FE    CP
0C83 40    40H
0C84 C2    LOOP
0C85 80    FOR
0C86 0C    MATCH
0C87 C3    JP TO
0C88 5C    0C5C
0C89 0C
MOVE DOWN
0C8A 97    CLEAR ACC
0C8B 23    INC HL
0C8C 3C    INC ACC
0C8D FE    CP
0C8E 40    40H
0C8F C2    LOOP
0C90 8B    FOR
0C91 0C    MATCH
0C92 C3    JP TO
0C93 5C    0C5C
0C94 0C

```



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Well - do you know how it works?

It has been observed that not only does a language (English, French etc!) provide a means of expressing thoughts, it also tends to limit thoughts, to those expressible in the language whether to others, or to one's self. Just as a road provides a path for transportation, if you get used to travelling by car you kind of have to stick to the road, and the surrounding terrain remains undiscovered.

So it is with computer languages. Iverson Notation was developed for humans to use, to advance their ability to think and solve problems. APL grew from this, and is probably the only language to pick up an already developed notation, as opposed to acting as a compromise between English and machine code.

Thus while other languages tend frequently to constrict one in trying to solve a problem, learning and using APL tends to help one to handle the problem. In fact with experience one seems to be able to write an APL program while thinking up the method of solution. Other languages usually require an intermediate block diagram or flow chart stage for a similar problem. The proof of this lies in the absolutely fanatical following for APL, and the well attended and highly regarded APL conferences which take place to discuss applications and possible new features for the language.

We think APL is great for the mind and body, and that it's about to arrive in a big way. This article deals with what it is, where it's been, and a look at when it should be used, and where it's going.

What It's Like

In as much as APL is quite different from other computer languages, has vastly different qualities, and has fanatical supporters, it is very useful to know something about the language itself.

APL having originally evolved from Iverson Notation, it is most helpful to start with those features which are actually part of the notation.

Iverson Notation

The first step to getting a grasp on Iverson Notation is to be familiar with a few 'buzz-concepts' essential to the topic.

Essentially Iverson Notation is a mathematical notation which permits expressions to be written in very compact and condensed forms. The idea is that by giving a lot of the most used functions single symbol names (instead of just + - x and ÷) the user can not only more easily write his ideas down, but even learn to think on a higher level. A good example of this is a sorting operation, for example putting a list of names in alphabetical order. Iverson Notation gives you the concepts of how to think of the list of names, and then allows you to write down, using just a couple of symbols, the method used to do it. Example later.

Data Type

In a mathematical expression, one may have a variety of different types of data. Most people are familiar with integers and real numbers, but also letters, words, collections of characters can be data.

Do not confuse, however, character data with names for variables. For example, in the ordinary algebraic expres-

sion $A=2 \times B$, A and B are variables while 2 is a constant. On the other hand, in a computer context it would be quite permissible for $C='ABCD'$, ie 'ABCD' is the 'value' of variable C.

Rank

In ordinary algebra we mostly use variables of a single 'element', known as scalars (eg $a=2$). Sometimes vectors are used, really a list of numbers known by one variable name (eg $a=3, 7, 2, -1$, or $a(1)=3, a(2)=7, a(3)=2$ and $a(4)=-1$). 'Matrices' are especially popular for such applications as solution of complicated equations, and have two 'subscripts'.

Example:

$$a = \begin{matrix} 1 & 3 & 0 \\ 7 & 5 & 4 \\ 8 & 7 & 2 \end{matrix}$$

or $a(1,1) = 1, a(2,1) = 7, a(3,3) = 2$, etc.

The concept of using subscripts can be extended on and on to any number of 'dimensions'. The general term for all such variables is 'array'. The number of dimensions or subscripts, it has is known as its 'rank'. Hence a (b,c,d) has rank of 3, a 2 dimensional matrix has a rank of 2, a vector rank 1, and a scalar has rank 0.

APL Applied

APL's big strength stems from the ability of a person familiar with the language to write a program as fast as thinking of the method. In fact one even tends to think of the solution in APL form. The other influential feature is that APL is an interactive language.

These two combine to produce an ideal way to use a computer for applications where the programs need to be ready fast, and where the applications area may be new (and hence the program is experimental and may require much revision). This is not to say that in other applications APL is not suitable, but until recently APL has been thought of as expensive in terms of execution time and memory use, or even simply to obtain access. In addition compared to other languages there are relatively few experienced APL programmers, the number familiar with the language will of course grow.

One estimate holds that an APL programmer can produce a program on the order of 25 times the speed of a COBOL programmer, (including debugging) and that the result is of course a far more compact listing.

One point to watch, however, is that while almost anyone can plough through a BASIC, FORTRAN or COBOL program (with enough patience), it is possible to program in APL in such a dense and tricky manner as to make the program virtually impossible to decipher by other persons. Programmers who do this also enjoy reducing 100 line FORTRAN programs to an APL one-liner. (There seems to be some special attraction to the 'one-line' challenge!).

However, if a program is written with reading also in mind, with a bit of descriptive documentation, there is no problem.

APL EXPLAINED

What APL Looks Like

SCALAR DYADIC FUNCTIONS

X+Y	X plus Y
X-Y	X minus Y
X*Y	X times Y
X÷Y	X divided by Y
X↑Y	X to the Y-th power
X∨Y	Maximum of X and Y
X∧Y	Minimum of X and Y
X⌊Y	X-residue of Y
X⌈Y	Base-X logarithm of Y
X!Y	Binomial coefficient
X⌈Y	Y items taken X at a time
XOY	See trigonometric functions
X<Y	X less than Y
X≤Y	X less than or equal to Y
X=Y	X equal to Y
X≥Y	X greater than or equal to Y
X>Y	X greater than Y
X≠Y	X not equal to Y
X∩Y	X and Y
X∪Y	X or Y
X≡Y	Not both X and Y
X≡Y	Neither X nor Y

TRIGONOMETRIC FUNCTIONS

R=XOY	
Y (in radians)	(R in radians)
X R	X R
0 (1-Y*2)*.5	
1 Sine Y	1 Arcsin Y
2 Cosine Y	2 Arccos Y
3 Tangent Y	3 Arctan Y
4 (1+Y*2)*.5	4 (1+Y*2)*.5
5 Sinh Y	5 Arcsinh Y
6 Cosh Y	6 Arccosh Y
7 Tanh Y	7 Arctanh Y

SCALAR MONADIC FUNCTIONS

+Y	Y
-Y	0-Y
xY	Signum Y
1Y	Reciprocal of Y
eY	e to the Y-th power
⌈Y	Ceiling of Y
⌊Y	Floor of Y
!Y	Absolute value of Y
*Y	Natural logarithm of Y
!Y	Factorial Y; Gamma Y+1
⍲Y	Pi times Y
?Y	A random number from 1-Y
~Y	Not Y

* ⍲CT dependent
⍲IO dependent

SYMBOLS

()	Parentheses for nesting
[]	Brackets for indexing
⌈ ⌋	Quad for input-output
⌈ ⌋	Quote-quad for character input
⌈ ⌋	Quote delimit character literals
⌈ ⌋	Lamp indicates comment
⌈ ⌋	Negative sign
E	Exponential notation
Δ	Delta Trace (Td) and stop (Sd) control
⌈ ⌋	I-beam for system functions
.	Decimal point
⌈ ⌋	Caret locates errors
;	Semicolon separates list elements
⌈ ⌋	Diamond used as statement separator
⌈ ⌋	Branch
:	Colon delimits labels and locks
⌈ ⌋	Squish-quad display of non-printable characters

The following characters are available as graphics

⌈ ⌋ ⌈ ⌋ ⌈ ⌋ ⌈ ⌋
⌈ ⌋ ⌈ ⌋ ⌈ ⌋ ⌈ ⌋

FUNCTION DEFINITION

Function definition is opened or closed by ⌈
Use of ⌈ at the close will lock the function
The following are valid with open definition

⌈	Display entire function
⌈	Display line n
⌈	Display from line n to the end
⌈	Display line n and position at p prior to editing
⌈	Display line n and position at right-hand end of line (Re)define line n

MIXED FUNCTIONS

XoY	Reshape Y to have dimensions of X
oY	Dimensions of Y
X[Y]	Y-th elements of X
X1Y	First locations of Y within vector X
1Y	Y consecutive integers from origin (0 or 1)
XeY	Membership of X in Y
X?Y	Representation of Y in number system X
X!Y	Value of the representation Y in number system X
X?Y	X integers selected randomly without repetition from 1-Y
XΦ[Z]Y	Rotation by X along the Z-th dimension of Y
Φ[Z]Y	Reversal along the Z-th dimension of Y
XbY	Transpose of Y according to X
bY	Transpose of Y (Φ100Y)⌈Y
X,[Z]Y	Catenate or laminate Y to X along Z-th dimension
,Y	Ravel of Y (makes Y a vector)
X+Y	Take first or last X elements of Y as X is + or -
X-Y	Drop first or last X elements of Y as X is + or -
X÷Y	X is assigned the value of Y
ΔY	Index vector such that Y[ΔY] is in ascending order
Y	Index vector such that Y[Y] is in descending order
X[Z]Y	X (logical) compressing along the Z-th dimension of Y
X\Z]Y	X (logical) expanding along the Z-th dimension of Y
R÷XBY	Matrix divide: X approximates R÷xY
⌈Y	Generalized matrix inverse of Y
⌈Y	Executes the character string Y
⌈Y	Character representation of Y
X#Y	Numeric expression Y is converted to character according to numeric format control vector X

• below denotes any scalar dyadic function

• applied cumulatively along the Z-th dimension of Y
The • reduction along the Z-th dimension of Y
Generalized outer product of X and Y
Generalized inner product of X and Y
e.g. X•xY is ordinary matrix product of X and Y

Φ applied to first dimension (reverse or rotate)
/ applied to first dimension (compress or reduce)
\ applied to first dimension (expand or scan)

If the expression [Z] is omitted, the operation applies to the last dimension of the argument array Y. The expression [Z] is ⍲IO dependent

SYSTEM COMMANDS

Note: Bracketed words are optional

⌈[n]	Allow editing of immediate execution line at position n
⌈[n]	Sign-on - invalid sign-on acts as ⌈[n]
⌈[n]	Print a mask for typing secure information
⌈[n]	Clear the active workspace
⌈[n]	Terminate a session and store the active workspace in CONTINUE
⌈[n]	Copy objects from a workspace
⌈[n]	Delete a stored workspace
⌈[n]	Erase objects
⌈[n]	List names of functions
⌈[n]	Define a group
⌈[n]	Disperse a group
⌈[n]	List members of a group
⌈[n]	List names of groups
⌈[n]	Lock keyboard (to receive messages)
⌈[n]	Suppress incoming messages
⌈[n]	Return keyboard to normal state
⌈[n]	List names of workspaces in library
⌈[n]	Activate a copy of a stored workspace
⌈[n]	Send message to designated terminal
⌈[n]	Send message to designated terminal without locking sender's keyboard to receive reply
⌈[n]	Terminate a work session
⌈[n]	Send message to SHARP APL operator
⌈[n]	Send message to SHARP APL operator without locking sender's keyboard to receive reply
⌈[n]	As ⌈[n], but protect contents of active WS from being overwritten
⌈[n]	List port number and task-ID of user aaa
⌈[n]	List port number and task-ID of user nnnnnn
⌈[n]	Clear the ⌈[n] stack
⌈[n]	Store a copy of the active workspace
⌈[n]	Lock all functions in the workspace, prevent dispersal of contents
⌈[n]	Display the state indicator
⌈[n]	Display state indicator and names of local variables
⌈[n]	Display/set symbol table size
⌈[n]	Display/set terminal type. See WS 5 TERM for current list of names
⌈[n]	List names of variables
⌈[n]	Display/set workspace name

Fig. 1. I.P. Sharp Associates provide a handy reference card for programmers using their systems. It is just about all you would ever need to remember or take with you to a desert island equipped with only an APL computer, on a scant 224 square inches of card. No more heavy manuals to lug around! Most of the information in this excerpt is general, we have included the section on system commands to give an idea of what is typical. The special characters shown here are those produced on an impact kind of typewriter terminal.

Functions

APL has a large number of characters which denote functions (examples are the familiar + - x ÷ but there are many more exciting ones! A couple of useful words to know here are 'monadic' and 'dyadic' which mean 'having one argument' and 'having two arguments' respectively. Note that each argument may be an array. Thus A+B may yield a scalar if A and B are scalar, but if they are arrays of the same size and shape, each element of A is added to the corresponding element of B to make the corresponding element of the resulting array.

Consistency And Execution Order

One of the great virtues of Iverson Notation is its consistency. All monadic functions are written with the one function symbol to the left of the argument, such as !F which means the factorial of F, ÷X which is the reciprocal of X, or ?Y, a random selection from the first Y integers, while A means absolute value of A. And remember F,X,Y and A could be arrays! In fact, the APL user tends to think that the basic data form is the array, which occasionally 'happens' to be a scalar or vector.

Similarly, all dyadic functions are written with the symbol between the two arguments.

Finally, execution order is right to left, regardless of functions (ie x does not take precedence over +). The order may be changed using brackets. This order is consist-


```

      ACCUM[0]
    ▽ Z ACCUM A;B;L
[1] A IMPROVED
[2] A←A[↑A[;1];]
[3] B←A[;1]
[4] L←(1↓B)≠1 B
[5] L←L,1
[6] B←L/B
[7] A←L/+ A[;2]
[8] A←A-0, 1 A
[9] Z←B,[1.5] A
    ▽
    ▽ CHARS[0] ▽
    ▽ Z CHARS X;A
[1] A RETURNS A LIST OF CHARACTERS IN (X),
[2] A SORTED ACCORDING TO THEIR POSITION IN
    AV
[3] A←' ', CHAR
[4] Z←AεX
[5] Z←Z/A
[6] X←(X X)=fX)/X (XεA)/X
[7] X←AV X,Z
[8] Z←AV[X[ X]]
    ▽
    ▽ DEB[0] ▽
    ▽ Z DEB X
[1] A DELETE LEADING, TRAILING AN EXTRA
    1 0fX IN (X)
[2] Z←1 0fX
[3] →(1=ffX)fL1
[4] X←X
[5] L1:Z (- Z←1↑Z)↓X (Zv0, 1↓Z X≠Z)/X
    ▽
    ▽ DLBDTB[0] ▽
    ▽ Z←DLBDTB X
[1] A REMOVES LEADING AND TRAILING BLANKS
    FROM TEXT INPUT (X)
[2] Z←(v Z) Φ
    ▽
    ▽ COMPRESSNAME[0] ▽
    ▽ Z←COMPRESSNAME NAME;L
[1] A AN ALGORITHM FOR NAME COMPRESSION
[2] A [1] DELETE SECOND ELEMENT OF REPEATED
    CONSONANT PAIR
[3] A [2] DELETE 'AEIOUY' EXCEPT WHEN FIRST
    LETTER IN NAME
[4] A 1ST STATEMENT IS NOT ABSOLUTELY
    REQUIRED
[5] A
[6] →(fNAME←DEB NAME)↑fZ ''
[7] Z←nL NAME 'AEIOUY'
[8] L←(0,1 L) NAME=1↓NAME,' '
[9] Z←L/NAME

```

Fig. 2. Another example of what APL looks like, this printout from a DEC dot matrix terminal. The resolution is not quite as good, nor the resulting characters so exotic looking, but the terminal is faster and quieter.

ent with the normal use of functions such as sin, log, d/dx etc.

The APL Character Set

In order to write all functions compactly, a large collection of new symbols was designed, which is now fossilized in the type elements of various impact type terminals. These usually have all the upper case letters, plus numbers and punctuation and so forth, and of course quite a selection of

not normally found symbols. Even more symbols are made by backspacing and over striking a second symbol on the first. (eg A, and ÷ to make ÷ etc).

Before non-APL fans get turned off by all this new symbology, it must be said that learning these symbols is extraordinarily easy, as many of them remind you of their meaning by their shape.

Two important notes to make: the use of the proper multiply sign (rather than an asterisk for multiply as in many languages) and instead of =. This is a logical choice since A A+1 really means 'A is assigned the value A+1', rather than 0=1. (By the way, APLers often say 'gets' rather than 'is assigned the value').

In Fig. 1 is a listing of APL symbols and their meanings, while Fig. 2 shows what a typical output looks like and there are more annotated examples in Fig. 3.

Environment

The implementation of Iverson Notation as a computer language brought real muscle to the elegant notation. As a computer language it is used interactively, that is to say you sit at a terminal (or at your personal APL machine!) and communicate directly and immediately with the computer.

You have the option of typing a statement and obtaining its result on the spot (immediate execution mode), writing a function or program (function definition mode), and executing such a function or program (again — immediate execution mode). Various editing and line numbering facilities are provided for function writing, and diagnostics and error messages help to debug functions.

The Workspace

On 'big systems', each APL user has a 'workspace', a fenced-off piece of memory, as it were, of some arbitrary size, say 50k bytes, where all his work is stored, all variables functions and programs, and in which the programs are executed. On completion of a session the user can store his workspace, even including partially executed programs, as complete state information is contained in the workspace. This storing process is usually onto disk, and is done in a relatively fool proof way as the user signs off. The workspace then sits in suspended animation, awaiting the user's continued efforts next time.

A user may also copy functions from another workspace into his own, (if so permitted) which of course gives access to a lot of useful software which others on the same system have developed.

Other Big System APL Features

Just as a user may copy information from another workspace, so can he access system 'libraries' where large volumes of software are typically found, such as routines for plotting, various engineering, statistical, and work processing packages, and of course games.

Additionally, extensive file systems (usually disk) are generally available for storing large amounts of program code or data.

APL Characters On Existing Machines

How do you put APL on a machine which has no APL character set? While new machines will be able to display the characters, and new character generator ROMs may satisfy a few other ways around the problem are possible.

One is to use three to five letter keywords instead of symbols, such that a single key could signify the function, and the whole keyword pops onto the screen. This doesn't

APL EXPLAINED

provide an elegant looking display, but it does give you APL with only a small sacrifice.

Implementation On Micros

The workspace, library and file concepts are more system dependent than the Iverson Notation part of APL. They are also likely to be seen only in limited form at first on small systems. For instance, one workspace is likely to be almost the entire memory of a micro-based machine, so there will be only one user at a time. A disk unit will be essential, for

storing workspace(s) and files, and one will presumably be able to create one's own libraries, or buy library disks with various useful packages on them.

'Virtual Workspace' schemes are already being worked on, wherein the user thinks he has a large amount of memory available, when in fact the machine has only a small amount, but swaps portions of the workspace on and off a disk as they are needed. This requires some fancy memory management to accomplish effectively.

```

      ▽ ENTRY
[1]  B 10 '
[2]  A←A,B
[3]  →1↑Bx' * '
      ▽
      ▽ RESHAPE
[1]  C←(fA)÷10,10
[2]  D←CfA
      ▽
      ▽ ORDER
[1]  E←ALPHA D
[2]  L←1↑C
[3]  F←E, L
[4]  N←10
[5]  F←F[↑F[;N];]
[6]  N←N-1
[7]  →5+3XN=0
[8]  ▽ D←D[F[;11];]

```

ENTRY allows the user to enter a list of names, one at a time, allotting ten characters to each name, and filling any unused positions with blanks.

ENTRY stops if the user types a single "*".

The resulting vector is A.

RESHAPE changes the list of names from a vector to an array with one name per row.

ORDER takes the array D, makes a numerical array E whose entries represent the letters in D, according to ALPHA. E is sorted by row, and the new order is then imposed on D. Job finished!

ALPHA
ABCDEFGHIJKLMNOPQRSTUVWXYZ

ENTRY

JOHN
FRED
ANDY
*

JOHN A FRED ANDY
B
*

RESHAPE

10 C D
JOHN
FRED
ANDY
*

ORDER

E										F										
11	16	9	15	1	1	1	1	1	1	2	15	5	26	1	1	1	1	1	1	3
7	19	6	5	1	1	1	1	1	1	7	19	6	5	1	1	1	1	1	1	2
2	15	5	26	1	1	1	1	1	1	11	16	9	15	1	1	1	1	1	1	1
28	1	1	1	1	1	1	1	1	1	28	1	1	1	1	1	1	1	1	1	4

L

D

ANDY
FRED
JOHN
*

Fig. 3. An example of how to sort a list of names. The 3 functions are listed at the top. Below is a series showing what the user did (indented), and what the machine's response was (Yes, we know it could be done in one line or less).

```

      ▽ EXAMPLE
[1]  A←' '
[2]  ENTRY
[3]  RESHAPE
[4]  ORDER
[5]  ▽ D←D

```

User executes the function ORDER, and the resulting values of E, L, F, and finally what we were waiting for . . . D, now in order.

EXAMPLE is a function which ties these three functions together into one, and then prints the result out.

Where has APL Been?

Recent Micro Moves

Until recently there hasn't been much stirring in the way of APL for the microcomputer system, in the way BASIC has been available for every microcomputer around.

Now, suddenly there appears to be a terrific battle brewing, as the race is on to feed APL to what is expected to be an open-mouthed market. Judging by the almost astounding enthusiasm of current APL users, each new user will be spreading the word far more quickly than was true with BASIC, that is if he can tear himself away from the console!

Videobrain

First out with APL appears to be umtech with their F8 based Video Brain. Fitting into 13k — worth of ROM-in-a-cartridge, APL/S is a subset of 'full APL', although there is no standard APL. While a standard for APL is being worked on, big machine versions provide a reference which differs only slightly from one to another, and then only in house-keeping facilities rather than in the basic notation.

Z80 And Vanguard

Vanguard Systems Corp. have announced an APL interpreter on floppy disk for Z80, and of course all companies with Z80 based machines are eagerly waiting for it. It is reported to be 27K.

Microsoft

Meanwhile, over at Microsoft, much brain work is going into the development of APL interpreters for all kinds of processors, past present and future, ie 8080, Z80 and the 16 bit micros 8086, Z8000 and 68000. Bill Gates, president and APL Product Manager at Microsoft figures fall '79 will be the time his 8080 and Z80 interpreters will be ready with the 16 bit versions in early 1980. Vanguard are hoping to manage the same feat.

It's Coming!

Well, it's almost here. It appears that the development of APL on a 16 bit microprocessor will make the first really comfortable implementation of APL for personal, home, business or educational use. Because of this general purpose nature most new APL machines will be easy to use and hence

either contain APL on ROM (fool proof) or on disk (most machines will have a disk or two anyhow).

Near Future

What is about to happen in the way of micro APL?

'APL will see an incredible increase in popularity because it will be exposed to so many new people. To date, it has been an expensive language to use and is almost never introduced to first time computer users. APL's strengths assure that a significant percentage of personal computer users will adopt it as "the language". However it is not the ideal first time language and has some limitations of its own. BASIC will continue to dominate in this role, although specialized languages will be supported by personal computer manufacturers. Microsoft will introduce APL on the TRS-80, Exidy Sorcerer, Interact One, Nascom and NEC TK-80 in 1979.

Also the old time APL users will enjoy the low cost and ease of access to the low priced machines. These old time users will be key in generating new converts. New tutorial material making APL seem less mathematical and not forcing the user to see the utility of all the operators will be required. The statistical, accounting and model type will be key ones for the new small business computers. With APL's following, IBM's support of it and its strength, our OEM's have decided they can't ignore it. Our response on the product to date has been incredible.

First Version

Details of the 8080/Z80 version: 'Our 8080/Z80 version (long awaited) will be out in April running under CP/M. Other versions such as the virtual workspace one will follow . . . Equivalence with the 5100 was my goal — and I met that with 24K of code.

We will license our APL to most of our existing OEM's.'

Performance

What kind of performance is expected from micro APL?

'Microsoft APL has all the features of IBM APL/SV (360/370) APL except that the I/O and shared variables are handled differently and the math will not be totally the same since we use binary exponents where IBM uses hex. Our



APL EXPLAINED

APL is twice as fast as the 5100 which is very adequate and often better than remote APL timesharing systems. Our 8086 and Z-8000 APL's will be at least five times faster and will be available in early 1980. This APL will outperform APL on most minis.

The string search and block transfer are an advantage that our Z-80 version will use. In specific cases this could cause a 2:1 speed difference, but overall the Z-80 to 8080 difference will be less than 15% at equal clock speeds. More important are the design techniques which allow a 32K byte work space to be equivalent to almost twice that much work-space on the 5100 through more efficient management and special representations.'

Far Future

Looking forward about a year Gates sees some of the following features being offered:

Workspaces up to 40K with virtual workspace to follow.
Libraries on disk.

Unlimited number of dimensions for arrays.

16 digit computation (floating point)

Availability of all primitives normally found.

Sophisticated system commands, error messages.

Initially only SAVE and LOAD workspace 'file' operations, but later random access I/O on arbitrary objects.

Later on Gates thinks 16 bit APL will have up to 10 meg workspaces, same library facilities as I.P. Sharp. Significantly, he comments that many language extensions may be persued, something he feels IBM has stifled. 'APL should not be allowed to stagnate. It is very weak in control structures. General lists should be added.'

I.P. Sharp

An interesting story came to our attention recently in

connection with micro APL. I.P. Sharp Associates, known worldwide for their APL communications network and software expertise, were apparently working on a micro based APL consumer product! Sharp's Steve Kohalmi described the project. A major Canadian manufacturer of entertainment products went to Sharp with the idea, and developed the hardware prototype while Sharp worked on the software. The produce was based on a GI 1600 micro-processor, and was to have floppy disk(s) and some colour graphics capability. The APL interpreter, which was developed on a PDP11/34 simulating GI code, has dynamic work-space management, floating point numbers, but only one dimensional arrays. 16K of 16 bit words was required. Unfortunately the whole combination was never tested as interest in further development has appeared to lapse. Anybody want to take over an almost debugged GI 1600 APL? Call Sharp.

Acknowledgements

Our thanks to the following people who were very helpful in the preparation of this article:

Bill Gates, Microsoft;
Chuck Williams, John Koiste, MCM Computers;
Steve Kohalmi, I.P. Sharp Associates;
I.P. Sharp Newsletter

Suggested Books

Kenneth E. Iverson: "Elementary Analysis"; APL Press, 1976.
The APL Press has available a comprehensive collection of publications on APL, the interested reader should write for a complete list.

Leonard Gilman and Allen J. Rose: "APL An Interactive Approach"; John Wiley and Sons Inc, 1974.

A.D. Falkoff and K.E. Iverson, "APL Language", IBM Corp, 1975 (Form No. GC26-3847)

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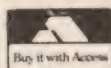
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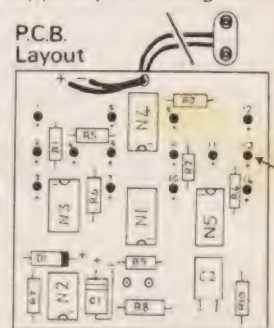
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A Tiny BASIC Star Trek program that will have you zapping Klingons till Stardate 29.35



The main object of this Startrek game is to destroy all the Klingon battle cruisers in the Galaxy, The Klingons, Stars and Starbases are randomly positioned within a simulated Galaxy which is divided into a matrix of 8 by 8 sectors, making 64 in all. The Federation starship Enterprise, of which you are in command, has been assigned the task of seeking out and destroying all the Klingon invaders. You have at your disposal an impressive arsenal of weapons, including phasers and photon torpedos which are under your direct control. The Enterprise may be replenished with energy and weapons by docking at a Starbase.

Commands

1) The HELM — This allows you to move the Enterprise through space to any point in your present sector, or to any other sector in the Galaxy. To do this you have to give a warp factor and a course which can be in any one of eight directions. At the end of each manoeuvre you are automatically given a short range scan.

(a) COURSE (0-7), see Figure. 1

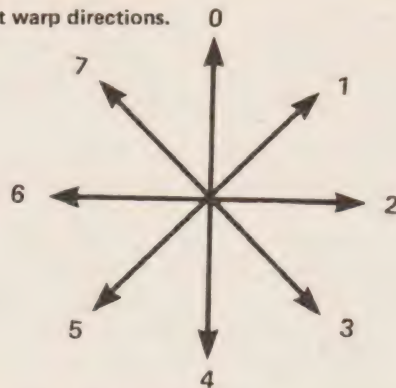
(b) WARP (1-63), gives you control over the number of units travelled, each unit being 1/8 of a sector.

NOTES (i) To move the Enterprise into another sector you merely give the Helm sufficient warp factor to get there, (each sector is 8 units wide).

(ii) You may not travel through Stars, Klingons or Starbases.

(iii) To dock at a Starbase you manoeuvre into an adjacent position to the left or right of the Starbase.

Fig.1 The eight warp directions.



2) LONG RANGE SCAN -- This gives you a summary of the objects in your present sector and adjacent ones. The information is displayed as a three figured number with the hundreds indicating the number of Klingons, the tens the number of Starbases and the units the number of Stars, as shown in Fig. 2.

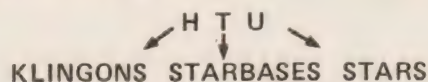


Fig.2 The long range scan display.

3) PHASERS — This is an energy weapon, the affect of which diminishes with distance. You are informed of the amount of energy left in the main banks and asked to enter the amount of energy to be diverted to the phaser weapon. To destroy a Klingon you have to deplete his energy to zero. On entering a sector, each Klingon has a full energy bank of 200 units. To calculate the effect of the phasers, the energy is divided equally between the Klingons in the current sector and is further reduced by dividing by the distance between the Klingon and the Enterprise. The result of this calculation is subtracted from the Klingon's energy bank.

Any Klingons left in the sector, after the operation of the weapon, shoot back. The hits on the Enterprise are calculated from the amount left in each Klingon's energy bank, divided by the distance between the Enterprise and the Klingon. However, if you are docked at a Starbase you are protected by its shields.

4) PHOTON TORPEDOS — These are a torpedo like weapon where a single bolt of intense energy is propagated in a single direction. Due to the high energy content of the bolt a Klingon or Starbase is destroyed by a single shot. Stars, however, will absorb the weapon. The bolts have an unlimited range within the current sector and are controlled only by direction. The direction command is the same format as that used in the HELM control: COURSE (0-7).

NOTES (i) You cannot shoot through Stars.

(ii) If you destroy a Starbase you are relieved of duty.

(iii) Any Klingons left after your attack will shoot back, using the same procedure as with the phaser weapon.

5) SHIELDS — The shields protect the Enterprise from enemy weaponry. Every hit on the Enterprise depletes the shields by the amount equal to the hit. To protect the Enterprise there must be enough energy in the shields to neutralise any attack or it will be destroyed.

After requesting the command you are given the total energy available, (the sum of the main banks plus that in the shields). You are then asked to enter the amount of energy to be diverted to the shields.

- NOTES (i) If the command reduces the energy in the shields, any surplus is diverted to the main banks.
 (ii) When docked at a Starbase you are protected by the Starbase shields.
 (iii) As well as being attacked when you shoot at the Klingons, you may also be attacked on a random basis, if the condition is red and you are executing the HELM, SHORT RANGE SCAN or LONG RANGE SCAN commands.

6) SHORT RANGE SCAN — This gives you the positions of the Stars, Klingons, Starbases and the Enterprise in your present sector. You are also given the stardate, the status of the main energy banks, your condition, (GREEN, RED, DOCKED), the number of photon torpedos left, the shield energy and the total number of Klingons left in the Galaxy.

7) RESIGNATION . . .

Video Display Characters

The objects in the Galaxy are displayed as follows:—

Object	Displayed Character
Enterprise	-0-
Klingon	>!<
Star	*
Starbase	<0>

Comments on Program Conversion for other Computers

- 1) The IF statement operates on the rest of the line and can be used to control multiple statements.
- 2) The N in the PRINT statements control the number of digits printed.
- 3) The RND(N) function generates a random number between 1 and N.
- 4) The TRITON variables are two byte integers which is the minimum length for the program's operation.

Program Notes

Line Nos.

- 20 — 90 Initialisation of variables.
 100 — 150 Initialisation of sectors. Each sector is represented as a single number — the hundreds representing the number of Klingons, the tens the number of Starbases and the units the number of Stars.
 160 Choose the initial current sector.
 170 Choose the initial position of the Enterprise in the current sector.
 180 — 190 Joins up the ends of the Galaxy.
 200 — 330 Sets up the positions of the Stars, Starbases and Klingons in the current sector.
 200 — 220 Decodes the sector number.
 230 Zeros sector and loads Enterprise position.
 245 — 260 Sets up the Stars.
 270 — 290 Sets up the Starbases.

- 300 — 320 Sets up the Klingons.
 360 — 370 Tests for Enterprise condition — GREEN, RED, DOCKED.
 380 Reloads weapons and energy banks when condition DOCKED.
 400 — 540 Short Range scan outputs the position of the Stars, Starbases, Klingons and the Enterprise; also gives information on the stardate, energy banks, shields, torpedos, total number of Klingons in the Galaxy, etc.
 550 Random test for Klingon to fire on Enterprise after a command.
 600 Test for all Klingons destroyed.
 605 — 620 Select command (1-7)
 1000 — 1140 HELM control (1)
 1000 — 1035 Read warp factor.
 1045 Blank Enterprise position in the current sector matrix: decrement energy and increment date.
 1090 — 1130 Move Enterprise W units.
 1135 Calculate new sector if Enterprise leaves the current sector.
 1140 Put new Enterprise position into the current sector matrix.
 2000 — 2040 LONG RANGE SCANE (2)
 Prints out the sector numbers of the current sector and the surrounding ones.
 3000 — 3120 PHASER control (3)
 3000 — 3010 Prints energy reserve and reads phaser energy.
 3020 Decrement energy banks, and test for no Klingons in current sector.
 3030 Divide phaser energy by the number of Klingons in the current sector and calculate the Enterprise position vector.
 3040 — 3050 Search current sector matrix for Klingons.
 3060 — 3070 Calculate distance between Enterprise and Klingons: Decrement Klingon energy bank.
 3080 Test for Klingon destroyed and take appropriate action.
 3090 Klingon not destroyed so store new Klingon energy level: Calculate hit on Enterprise and subtract from shields.
 3110 Test for destruction of the Enterprise.
 3120 Updates the number of Klingons in the current sector.
 4000 — 4080 PHOTON TORPEDOS control (4)
 4000 Test for no torpedos
 4010 Read course: decrement number of torpedos.
 4010 — 4050 Step along course until object encountered.
 4060 Test for Starbase hit.
 4065 Test for object not a Klingon.
 4070 Klingon destroyed.
 4080 Set phaser energy to zero and jump to phaser routine to calculate the hits on the Enterprise shields from the remaining Klingons.
 5000 — 5030 SHIELD control (5)
 5000 Add shield power to that in the main energy banks: Prints total energy.
 5010 Read shield energy and subtract it from the main energy banks.
 5020 Jump for next command.
 6000 SHORT RANGE SCAN (6)
 Jump to short range scan routine.
 7000 RESIGNATION (7)
 8000 — 8030 Subroutine to calculate distance between the Enterprise and Klingons.
 8200 Klingon destroyed subroutine.

8300 Print energy subroutine.
 8500 – 8570 Subroutine to read course and calculate the
 direction increment vector.
 8600 Game lost: Stop.

NOTE

The subscripted characters in the PRINT statements used to display the Enterprise, etc., (line nos. 440 – 460) indicate the character is to be typed in conjunction with the control or shift key.

Fig.3 The program listing.

```

10 REM STARTREK SIMULATION PROGRAM
20 REM A TINY BASIC VERSION
30 REM I.L.POWELL 10/3/1979
40 K=0
50 T=RND(200)+200
60 E=3000
70 O=15
80 S=0
90 L=T
95 REM SET UP SECTORS
100 FOR I=0 TO 63
103 X=0
105 Y=0
110 IF RND(10)<8 X=RND(3)
120 IF RND(100)>88 Y=1
130 Z=RND(5)
140 @(I)=X*100+Y*10+Z
145 K=K+X
150 NEXT I
160 Q=RND(64)-1
170 A=RND(64)-1
180 IF Q<0 Q=Q+64
190 IF Q>63 Q=Q-64
199 REM SET UP CURRENT SECTOR
200 Z=@(Q)
210 X=Z/100
215 Z=Z-X*100
220 Y=Z/10
225 Z=Z-Y*10
230 FOR I=64 TO 127
233 @(I)=0
235 NEXT I
237 @(A+64)=4
240 FOR I=1 TO 5
245 IF I>Z GOTO 270
250 J=RND(64)+63
255 IF @(J)#0 GOTO 250
260 @(J)=3
270 IF I>Y GOTO 300
280 J=RND(64)+63
285 IF @(J)#0 GOTO 280
290 @(J)=2
300 IF I>X GOTO 330
310 J=RND(64)+63
315 IF @(J)#0 GOTO 310
320 @(J)=-200

```

```

330 NEXT I
340 REM SHORT RANGE SCAN
350 C=1
355 IF X#0 C=2
370 IF (@(A+63)=2)+(@(A+65)=2) C=3
380 IF C=3 E=3000; S=0; O=15
400 FOR I=0 TO 56 STEP 8
410 FOR J=64 TO 71
420 U=@(I+J)
430 IF U=0 PRINT ' ',
440 IF U<0 PRINT '>!',
450 IF U=2 PRINT '<0>',
455 IF U=3 PRINT '* ',
460 IF U=4 PRINT '-0-',
470 NEXT J
480 IF I=8 PRINT 'STARDATE',T
485 IF (I=0)+(I=56) PRINT
490 IF I#16 GOTO 500
492 PRINT 'CONDITION',
493 IF C=1 PRINT 'GREEN'
494 IF C=2 PRINT 'RED'
496 IF C=3 PRINT 'DOCKED'
500 IF I=24 PRINT 'ENERGY',E
510 IF I=32 PRINT 'TORPEDOS',O
520 IF I=40 PRINT 'SHIELDS',S
530 IF I=48 PRINT 'KLINGONS',K
540 NEXT I
550 IF L#T IF RND(9)<6 GOTO 4080
590 REM COMMAND CONTROL
600 IF K=0 PRINT 'THE FEDERATION
        HAS BEEN SAVED' ; STOP
605 INPUT 'COMMAND' B
610 IF (B>7)+(B<1) GOTO 600
620 GOTO B*1000
999 REM HELM CONTROL
1000 GOSUB 8500
1020 INPUT 'WARP(1-63)'W
1030 IF (W<1)+(W>69) GOTO 1020
1035 IF E W GOSUB 8300 ; GOTO 600
1040 @(A+64)=0
1045 E=E-W
1050 T=T+W
1090 FOR I=1 TO W
1110 IF (V<0)+(V>7)+(H<0)+(H>7)
        GOTO 1120
1113 U=0
1115 IF @(V+8*H+64)#0 V=V-N ;
        H=H-M ; GOTO 1140
1120 NEXT I
1125 IF V<0 V=V-8
1130 IF H<0 H=H-8
1135 IF U Q=Q+8*(H/8)+V/8 ;
        GOTO 170
1140 A=V+8*H
1150 @(A+64)=4

```


STAR TREK

```

1160 GOTO 350
1999 REM LONG RANGE SCAN
2000 FOR I=-8 TO 8 STEP 8
2010 FOR J=-1 TO 1
2015 U=Q+J+I
2020 IF U<0 U=U+64
2025 IF U>63 U=U-64
2030 PRINT #4,@(U),
2033 NEXT J
2035 PRINT
2037 NEXT I
2040 GOTO 550
2999 REM PHASER CONTROL
3000 GOSUB 8300
3005 INPUT 'PHASERS' P
3010 IF E<P GOTO 3000
3020 E=E-P
3025 IF X=0 GOTO 3120
3030 P=P/X
3033 H=A/8
3035 V=A-8*I
3040 FOR I=0 TO 63
3050 J=I+64
3055 IF @(J)>=0 GOTO 3110
3060 F=I/8
3065 U=I-F*8
3070 GOSUB 8000
3073 G=@(J)
3075 G=G+P/D
3080 IF G>=0 GOSUB 8200
3085 GOTO 3110
3090 @(J)=G
3100 IF C#3 G=-G/D ; S=S-G ;
PRINT #3,G,'HIT ON SHIELDS'
3110 NEXT I
3115 IF S<0 GOTO 8100
3120 @(Q)=(Q)-(@(Q)/100-X)*100
3130 GOTO 600
3999 REM PHOTON TORPEDO CONTROL
4000 IF 0<1 PRINT 'NO TORPEDOS' ;
GOTO 600
4010 GOSUB 8500
4013 0=0-1
4015 FOR I=1 TO 16
4020 V=V+N
4025 H=H+M
4030 IF (V<0)+(V>7)+(H<0)+(H>7)
GOTO 4080
4040 J=V+8*H+64
4045 IF @(J)#0 GOTO 4060
4050 NEXT I
4060 IF @(J)=2 PRINT 'STAR BASE
DESTROYED' ; GOTO 8600
4065 IF @(J)>0 GOTO 4080
4070 GOSUB 8200
4080 P=0
4090 GOTO 3020
5000 E=E+S
5005 GOSUB 8300
5010 INPUT 'SHIELDS' S
5015 E=E-S
5020 IF E<1 PRINT 'S>E' ;
GOTO 5000
5030 GOTO 600
5999 REM JUMP TO SHORT
RANGE SCAN
6000 GOTO 350
6999 REM RESIGNATION
7000 PRINT 'ACCEPTED'
7010 GOTO 8600
7900 REM SUBROUTINES
7910 REM CALCULATE KLINGON
ENTERPRISE DISTANCE
8000 Z=H-F
8005 Y=V-U
8010 FOR D=1 TO 8
8015 G=D+1
8020 IF G*G (Z*Z+Y*Y) RETURN
8030 NEXT D
8040 RETURN
8090 REM
8100 PRINT 'ENTERPRISE DEAD
IN SPACE'
8110 GOTO 8600
8190 REM
8200 PRINT 'KLINGON DESTROYED'
8210 X=X-1
8220 K=K-1
8230 @(J)=0
8240 RETURN
8290 REM
8300 PRINT 'ENERGY=',#5,E
8310 RETURN
8390 REM READ COURSE AND
CALCULATE MOVEMENT VECTOR
8500 INPUT (COURSE(0-7)) B
8510 IF (B<0)+(B>7) GOTO 8500
8520 M=0
8523 N=0
8525 H=A/8
8527 V=A-H*8
8530 IF (B<2)+(B>6) M=-1
8540 IF B>2 IF B<6 M=1
8550 IF B<4 IF B>0 N=1
8560 IF B>4 N=-1
8570 RETURN
8590 REM
8600 PRINT 'YOU ARE RELIEVED
OF DUTY'
8610 STOP

```


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- Available expander board features 24K static RAM (additional mini-floppy interface, port adapter for printer and modem and OSI 48 line expansion interface.
- Assembler/editor and extended machine code monitor available.

Commands

CONT	LIST	NEW	NULL	RUN	
Statements					
CLEAR	DATA	DEF	DIM	END	FOR
GOTO	GOSUB	IF...GOTO	IF...THEN	INPUT	LET
NEXT	ON...GOTO	ON...GOSUB	POKE	PRINT	READ
REM	RESTORE	RETURN	STOP		

Expressions

Operators
-, +, *, /, ^, NOT, AND, OR, >, <, <>, >=, <=, =
RANGE 10^{-32} to 10^{+32}

Functions

ABS(X)	ATN(X)	COS(X)	EXP(X)	FRE(X)	INT(X)
LOG(X)	PEEK(I)	POS(I)	RND(X)	SGN(X)	SIN(X)
SPC(I)	SQR(X)	TAB(I)	TAN(X)	USR(I)	

String Functions

ASC(X\$)	CHR\$(I)	FRE(X\$)	LEFT\$(X\$,I)	LEN(X\$)	MID\$(X\$,I,J)
					VAL(X\$)
				RIGHT\$(X\$,I)	STR\$(X)

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In part four of our series Ian Sinclair takes a look at some of the SC/MP's logical instructions

Your breadboard microprocessor is now in just about its final form, and we can spend some time looking at some more of the instructions which the 8060 can carry out. In Part 3, we ended up trying out the AND IMMEDIATE instruction, using the STOR sequence of 11001000, followed by 00000001 to display the final number in the accumulator. In this part, we'll kick off by looking at a few more of these IMMEDIATE instructions, starting with OR IMMEDIATE.

Immediately Logical

Like the AND IMMEDIATE, the OR instruction takes the byte which is stored in the accumulator and compares it bit by bit with an IMMEDIATE-loaded number, which is the byte following the OR instruction. Each bit in the accumulator is OR'd with the corresponding bit of the new number, obeying the rules of the two-input OR-gate as shown in Fig. 1. To demonstrate this action, go through the following sequence.

First of all, RESET. This is particularly important if you have just switched on, because the 8060, like all microprocessors, will start up with its register flip-flops in random order. All sorts of things can go wrong if you try to use it without clearing the decks first. Now CANCEL RESET, and go through the sequence of 11000100 PUSH 10101010 PUSH. This is LOAD IMMEDIATE followed by the data byte 10101010, an easily recognisable pattern, so that the accumulator is now loaded with this byte. Follow this with 11011100 PUSH 01010101 PUSH. The first byte of this pair is the OR-IMMEDIATE instruction, and the second is the data byte which is to be OR'd. Fig. 2 shows what the result should be — a complete byte of 1's.

This result should now be sorted in the accumulator, and to display the bits on the LEDs we use the sequence (which is going to become rather familiar) of 11001000 PUSH 00000001 PUSH. The address number will now be 0111 (we're coming up to the 7th push) and the LEDs will show the result, 11111111 as it ought to be.

Exclusive Instructions

The EXCLUSIVE-OR IMMEDIATE instruction uses the same sort of sequence, but the action is rather different, as Fig. 3 shows. The truth table for the 2-input X-OR gate gives a 1 output only for a single 1 input, and a zero when both inputs are 0 or both inputs are 1. As usual, the 8060 carries out the X-OR on eight bits at a time, using the sequence starting with RESET, CANCEL RESET, 11000100 PUSH 10101010 PUSH. This loads the accumulator with the data byte 10101010 as before. The next steps are 11100100 PUSH 11111111 PUSH. The first byte of this pair is the XRI (X-OR IMMEDIATE), and the second is the data byte. The X-OR of these two should give the byte 01010101, and this can be viewed by using the sequence 11001000 PUSH 00000001 PUSH as before. See Fig. 4. This XOR instruction is very often used to check that a byte which is stored in

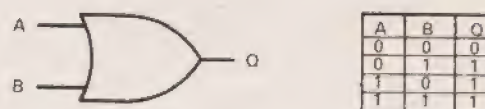


Fig.1 The 2-bit OR-gate and its truth table.

```

      1 0 1 0 1 0 1 0
OR 0 1 0 1 0 1 0 1
-----
    1 1 1 1 1 1 1 1
  
```

Fig.2 OR'ing two bytes together.

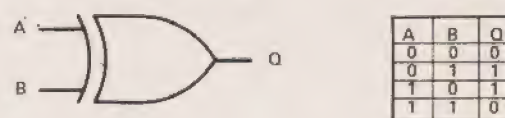


Fig.3 The 2-bit exclusive-OR (XOR) gate and its truth table.

```

      1 0 1 0 1 0 1 0
XOR 1 1 1 1 1 1 1 1
-----
    0 1 0 1 0 1 0 1
  
```

Fig.4 XOR'ing two bytes together.

the accumulator is identical to some other byte fetched from memory — if the two are identical, the accumulator contents will end up as zero, and a JUMP-IF-ZERO instruction can then guide the microprocessor to a new set of instructions.

Adding A Bit More

That disposes of the main logic instructions for the moment. Let's look now at the 8060 in action on some arithmetic — simple binary addition. From now on, also, we'll start to use the shortened forms of the instructions, or mnemonics, when we refer to the instructions in words. There aren't any short forms for the binary codes, though, until we take the step to hexadecimal programming later.

Binary addition follows simple laws which are summarised in the truth table of Fig. 5. As in decimal arithmetic, a 'carry' is added in to the next most significant pair of digits, that is the next to the left when we write the number in the usual way. The simplest of these ADD instructions in the 8060 set is the ADD BINARY IMMEDIATE, ADI, and we can now try out an elementary binary addition, starting in the usual way with RESET, CANCEL RESET. Now use

11000100 PUSH 00001111 PUSH so as to load the accumulator with the data byte 00001111. This is followed by 11110100 PUSH 00010101 PUSH, which is the ADI code followed by the byte which is to be added. As Fig. 6 shows, this should give the result 00100100, and this can be checked by the usual display sequence 11001000 PUSH 00000001 PUSH.

Now this instruction obviously carries out the binary addition in this example, but what happens if there is a carry out of the most significant bit? We can try it right now — prepare the chip in the usual way, and this time load in a large number by setting up the sequence: 11000100 PUSH 11111111 PUSH. Now follow with ADI, which is 11110100 PUSH, and another data byte 01111111 PUSH. Fig. 7 shows the result of this addition. To display, use 11001000 PUSH 00000001 PUSH. Since there are only eight DLEDs, we can see only eight bits of answer — so what has happened to the final carry bit?

The Question Answered

The answer appears if we follow this up with another piece of binary arithmetic without resetting. We shall add 1 and 1, which ought to give 00000010, binary 2, by using the sequence 11000100 (LDI) PUSH 00000001 (data) PUSH 11110100 (ADI) PUSH 00000001 (data) PUSH 11001000 PUSH 00000001 PUSH. The display might be expected to show 00000010, but it actually shows 00000011 — which is binary 3. The extra 1 which has been added in has been the 1 carried over from the previous addition. The question now is — where was this carry bit stored between times? The answer is that a flip-flop, one of a group of eight called, slightly misleadingly, the status register, was used to hold the carry bit, and to add it into the next sum. On the 8060, this bit is called the CARRY/LINK (CY/L) and is bit 7 (counting from 0, remember) of the status register. I've said that it's a trifle misleading to call this set of 'status' flip-flops a register; that statement needs an explanation. Usually a register contains a byte which represents a binary number, part of a binary number or a coded character (a letter or graphic symbol). The status set of flip-flops doesn't represent any byte; each flip-flop of the set is quite independant of the rest, so that each bit is set by actions which need not affect any of the others. On the other hand, the whole set of bits can be exchanged with the byte in the accumulator, so that the bits of the status register can all be changed or tested simultaneously if we want to do so. Because of this action, the name of register is justified.

The CY/L bit is particularly useful when large binary numbers have to be added. This is done by breaking the numbers down into groups of eight bits, and then adding corresponding bytes, as illustrated in Fig. 8. If we start, as would be normal, with the lowest order byte, then the CARRY/LINK ensures that a carry bit is correctly added to each successive byte as required, but without needing any special program instructions.

Reveal Your Status

While we're on the subject of the status register, we might as well take a look at this CY/L bit by teasing it out of its lair. RESET, CANCEL RESET, and do the addition of 11111111 to 01111111 again, but without the final two display steps. Now set up 00000110 PUSH. This is the COPY STATUS TO ACCUMULATOR (CSA) instruction, which, as the name suggests, loads the accumulator with the same pattern of bits as are contained in the flip-flops of the status register,

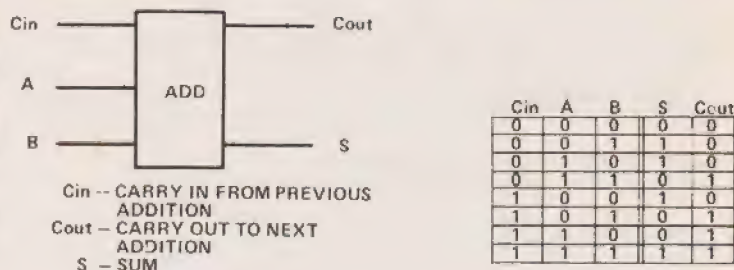


Fig.5 The ADD function and its truth table.

```

      0 0 0 0 1 1 1 1
ADI  0 0 0 1 0 1 0 1
-----
      0 0 1 0 0 1 0 0

```

Fig.6 ADD IMMEDIATE operations on two bytes.

```

      1 1 1 1 1 1 1 1
ADI  0 1 1 1 1 1 1 1
1 ← 0 1 1 1 1 1 1 0
CARRY -----

```

Fig.7 A carry out of the byte.

```

      1 0 0 1 0 1 1 0 1 1 1 0 0 1 1 0
ADI  0 0 1 1 1 0 1 1 1 0 0 1 0 1 1 1
-----
      1 1 0 1 0 0 1 0 0 1 1 1 1 1 0 1

HIGHER BYTE      LOWER BYTE
1 0 0 1 0 1 1 0  1 1 1 0 0 1 1 0
0 0 1 1 1 0 1 1  1 0 0 1 0 1 1 1
1 1 0 1 0 0 1 0  carry ← 0 1 1 1 1 1 0 1

```

Fig.8 Double-byte arithmetic. Using the carry/link bit lets us carry out sixteen-bit arithmetic in two steps, adding the lower order bytes first.

without changing the status register in any way (it's a *copy* instruction, not an *exchange* instruction). We can now display this byte by the usual sequence of 11001000 PUSH 00000001 PUSH. This causes DLED 7 to glow, indicating that bit 7 (the eighth, remember, because we start at 0) of the status register was set by the addition operation.

This CY/L bit can be set or reset by program operations which do not involve addition. The instruction 00000010 clears the CY/L bit — set up this code on the data switches, PUSH, and then go through the sequence of 00000110 (CSA) PUSH 11001000 PUSH 00000001 PUSH to display the status register. Similarly, the instruction 00000011 PUSH sets the CY/L bit to 1, you can check this one out for yourself using the method shown above, but substituting the set instruction for the clear instruction. The whole of the status register can also be changed by copying a byte from the accumulator (instruction CAS) to the status register.

Sometimes the automatic operation of the CY/L bit is a nuisance; the example we used showed how the second

MPU's BY EXPERIMENT

0 1 1 1 1 1 1 1
0 1 1 1 1 1 1 1
NOT CARRY FROM BYTE 1 1 1 1 1 1 1 0

Fig.9 An addition with no carry out of the byte — but the overflow flag is set.

AS CARRIED OUT		INTERPRETATION	
8th	7th	UNSIGNED	SIGNED
1	1	193	-63
1	1	+ 194	-62
1	0	387	-125
Carry from 7th and 8th = 256		(remember carry = 256)	

8th	7th		
1	0	129	-127
1	0	+ 130	-126
1	0	259	-253
Carry from 8th only (remember = 256)		but answer does not have 1 in 8th place, so OV is set	

8th	7th		
0	1	65	+ 65
0	1	+ 66	+ 66
1	0	131	+ 131
Carry from 7th only		but there is a 1 in the 8th place, so OV is set.	

Fig.10 Using the OV bit to indicate when an answer may be wrongly read, when signed arithmetic is used. The binary addition is as carried out by the microprocessor, the decimal arithmetic is as we would interpret it.

of two additions could be affected by a carry from the first, which is why the CY/L clear instruction is available. This program instruction would always be used between separate additions to avoid unwanted carries, and is often used at the start of a piece of program in case the CY/L has not been previously cleared. At the start of a program or subroutine, the most convenient way of clearing the CY/L bit is to load the accumulator with zeros, and then copy the accumulator byte to the status register, using the CAS instruction, so that all the bits of the status register are set to 0.

Let's look at another status bit (or flag) which is affected by addition. The addition sum this time is as shown in Fig. 9, there's no carry out of the most significant bit from this one. RESET and CANCEL, then load and add by using the sequence 11000100 (LDI) PUSH 01111111 (data) PUSH 11110100 (ADI) PUSH 01111111 (data) PUSH. This should not have set the CY/L bit, and we can show this by copying the status register to the accumulator, using 00000110 (CSA) PUSH and displaying by the sequence 11001000 (PUSH) 00000001 (PUSH).

Some Light On The Problem

There's certainly no light on DLED7, but DLED6 is lit! This indicates that another status flag has been set, and this one's called overflow (OV). Why should this be set? The reasons are a bit (sorry) complicated and will take some time to explain, but the mechanism is straightforward — the OV bit is set by the result of X-ORing the carries from bits 6 and 7 in an addition. If there's a carry from one of these places only, the OV bit is set. If there's a carry from both places, or no carry from either, the OV bit remains reset at 0. Unlike the CY/L bit, the OV bit is not added into subsequent additions, it's purely a warning.

A warning of what? Well, the OV bit comes into its own when the most significant bit of an 8-bit number is used to represent the sign of the number. The convention is that a 1 in the most significant place represents a negative number in 2's complement form, and 0 represents a positive number. The microprocessor itself treats all binary numbers in the same way, simply as numbers, but the OV bit is set to warn if a mistake could take place when the numbers are being interpreted as signed numbers, that is taking the most significant bit as a sign bit. It's not the microprocessor which is likely to make the mistake, but the user, which is why the OV bit is simply a warning.

Have a look at the examples in Fig. 10. Now if we regard these simply as eight bit binary numbers, with the most significant bit used as a digit, then all the binary additions are straightforward and valid. This is how the microprocessor will treat these additions. If we take the MSB as representing sign, however, things look rather different. Addition (a) is of -63 to -62, giving -125. A negative answer should have a MSB set to 1, which is the case in this example, and the carry out of the most significant bit can be ignored. Because this addition is valid *however we interpret it*, the OV bit is not set, though the CY/L is.

Addition (b) is of -126 to -127, and the result should be -253 if we're interpreting the sign bits correctly. It certainly works out correctly if we convert back, but the MSB is NOT 1, so that we would not convert this number in the normal run of events. For such an operation, the OV bit is set to warn us that the number is a negative number even though the MSB is zero. Addition (c) is of two positive numbers, but the answer has a 1 in the MSB position, indicating a negative sign. In this case also, the OV bit is set to 1.

Signing Off

The OV bit, then, warns that the sign of the MSB is wrong when we are interpreting the numbers as signed numbers, and the bit is set only when there is a carry out of D6 OR D7 but not both. It's then up to the programmer to make use of this OV bit to correct the sign if needed. In these additions, the microprocessor goes about its additions in the same way regardless of how we think of the numbers. As we'll see later, there are some instructions in which the microprocessor will take the MSB as indicating a sign.

There are no special instructions in the 8060 set for setting or resetting the OV bit apart from the others in the status register, because it's purely an advisory bit which does not affect any subsequent operation. It can be detected, set or reset only by the CSA and CAS instructions, along with all the other bits in the status register. All in all, it gives you some respect for the programs which are built into these pocket calculators which play with negative numbers as easily as with positive ones!

1 Dimensional Life for MK14

Many readers will be familiar with the Game of Life which is played by a computer on a 2 dimensional grid of cells. This has been adapted for the MK14 by arranging all the cells in a line. The field is 16 wide, an occupied cell is represented by a vertical bar and each digit of the display contains 2 cells.

The rules are as follows:—

- i) If a cell is vacant, one is born if it has 2 or 3 neighbours.
- ii) If a cell is occupied it dies if it has 1 or 3 neighbours.
- iii) In 1.D. life each cell has 4 "adjacent" cells, i.e. 2 either side.

Mode Of Operation

The 16 cells have locations 0E80-0E8F. These are filled with the starting configuration, X'01 for occupied and X'00 for vacant.

GOing from 0FA0 causes this and subsequent generations to be displayed.

The display port of the program could be altered to give the status of the cells on 16 LED's connected to the output ports.

To improve the display; If address 0FC0 is changed to C4 63 and 0FCB to DC 5C then the cells become small squares.

0F4E 98 20
0F50 03
0F51 FC 01
0F53 98 1B
0F55 90 21

JZ Born If sum = 2 or 3 then
SCL jump to born.

CAI X'01
JZ Born
JMP Same Otherwise as before.
3 x NOP Gaps filled with
NOPs

Space:

0F5A 03 SCL
0F5B C0 BA LD Sum
0F5D FC 02 CAI X'02
0F5F 98 17 JZ Same
0F61 03 SCL
0F62 FC 02 CAI X'02
0F64 98 12 JZ Same
4 x NOP

Dies:

0F6A C4 00 LDI X'00 Otherwise dies.
0F6C CA FE ST FE (2) (clear location)
0F6E 90 08 JMP Same

Born:

0F70 C4 01 LDI X'01 Cell is born
0F72 CA FE ST FE (2) (set location)
4 x NOP

Program listing for 1 Dimensional Life

0F12 T0 = +1
0F13 T1 = +1
0F14 T2 = +1
0F15 N = +1
0F16 Sum = +1

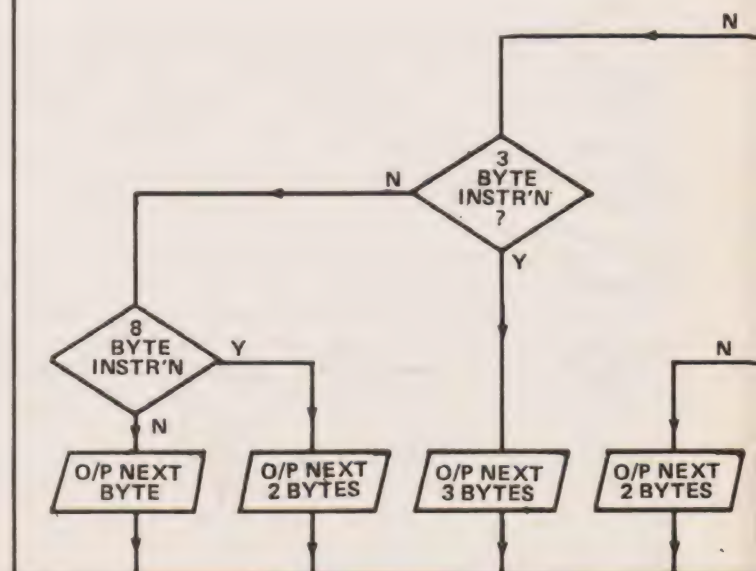
Start:

0F20 C4 0E LDI X'0E
0F22 36 XPAH (2) P2 = 0E80
0F23 C4 80 LDI X'80 (or start of cells).
0F25 32 XPAL (2)
0F26 C4 00 LDI X'00
0F28 C8 EC ST N
0F2A C8 E8 ST T1
0F2C C8 E7 ST T2 clear stores
0F2E CA 11 ST X'11 (2)
0F30 CA 10 ST X'10 (2)
4 x NOP gaps filled with
NOPs

Next:

0F36 C6 01 LD 01 (2) @
0F38 C8 D9 ST T0 T0 = state of cells.
0F3A 02 CCL
0F3B C0 D7 LD T1
0F3D F0 D6 ADD T2 Sum = no of
0F3F F6 01 ADD 01 (2) @ neighbours
0F41 F2 00 ADD 00 (2)
0F43 C8 D2 ST Sum
0F45 C0 CC LD T0
0F47 9C 11 JNZ Space Jump if cell present
0F49 03 SCL
0F4A C0 CB LD Sum
0F4C FC 02 CAI X'02

Flowchart for the INTAB program (see next page).



Same:

0F78	C6 FF	LD FF(2) @	Decrement pointer.
0F7A	A8 9A	ILD N	Increment counter
0F7C	E4 10	XRI X'10	and if all cells
0F7E	98 20	JZ Display	examined jump to
0F80	C0 92	LD T1	display.
0F82	C8 91	ST T2	T2 = T1
0F84	C0 8D	LD T0	
0F86	C8 8C	ST T1	T1 = T0
0F88	90 AC	JMP Next	go and examine next

0F9C		Cycles = +1	
0F9D		Count = +1	
0F9E		Seg = +1	
		Display:	Entry point
0FA0	C4 FF	LDI X'FF	Set cycles counter,
0FA2	C8 F9	ST Cycles	X'FF gives 5 seconds
			per generation.

0FA4	C4 0D	Again: LDI X'0D	
0FA6	35	XPAH (1)	P1 = 0D08
0FA7	C4 08	LDI X'08	
0FA9	31	XPAL (1)	
0FAA	C4 0E	LDI X'0E	
0FAC	36	XPAH (2)	P2 = 0E80
0FAD	C4 80	LDI X'80	(or start of cells)
0FAF	32	XPAL (2)	
0FB0	C4 10	LDI X'10	count = X'10
0FB2	C8 EA	ST Count	

Repeat:

0FB4	C4 FF	LDI X'FF	Delay
0FB6	8F 01	DLY X'01	
0FB8	C4 00	LDI X'00	
0FBA	C8 E3	ST Seg	Clear seg.
0FBC	C6 01	LD 01 (2) @	
0FBE	98 04	JZ N1	Jump if cell vacant
0FC0	C4 30	LDI X'30	otherwise seg = X'30
0FC2	C8 DB	ST Seg	

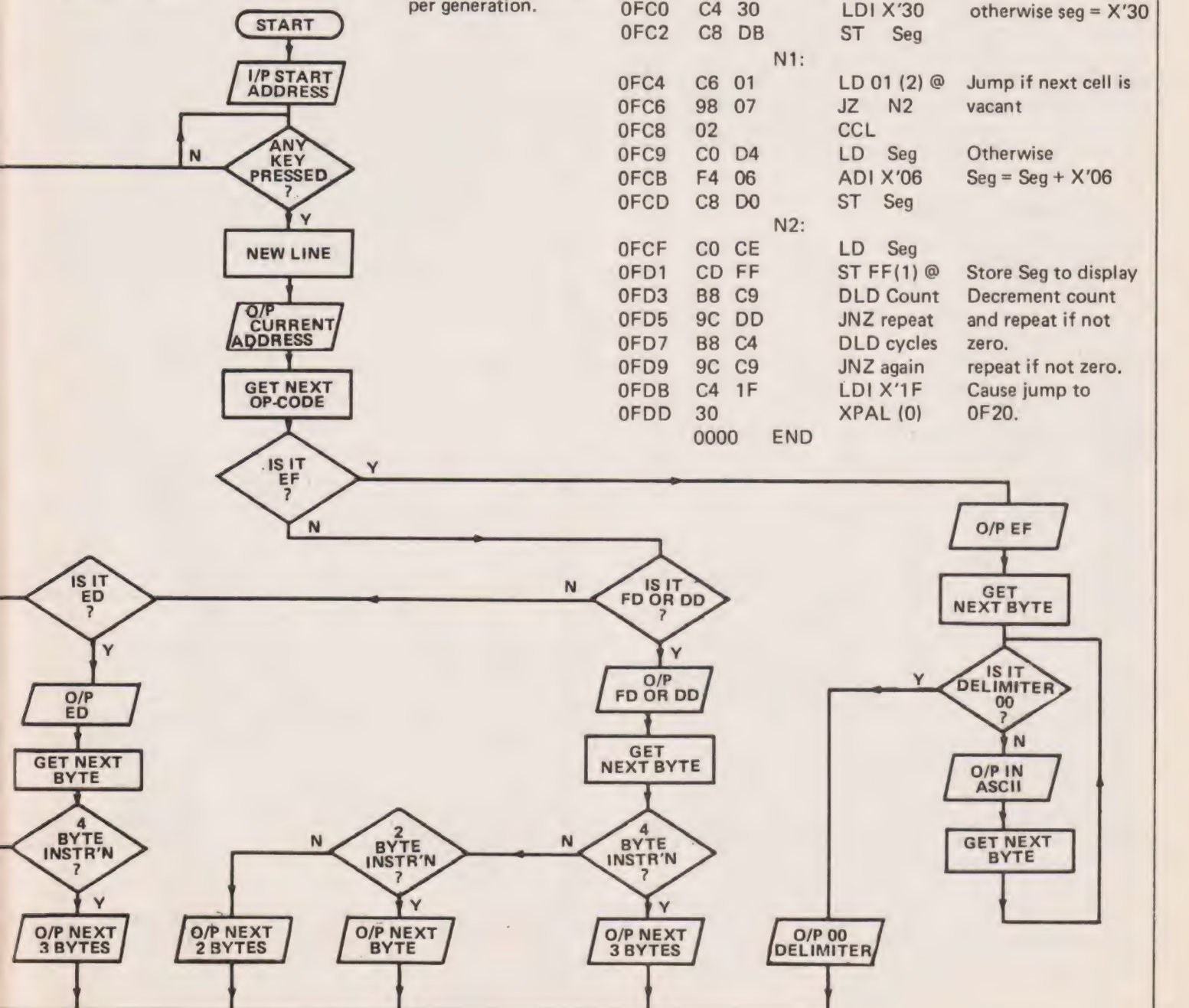
N1:

0FC4	C6 01	LD 01 (2) @	Jump if next cell is
0FC6	98 07	JZ N2	vacant
0FC8	02	CCL	
0FC9	C0 D4	LD Seg	Otherwise
0FCB	F4 06	ADI X'06	Seg = Seg + X'06
0FCD	C8 D0	ST Seg	

N2:

0FCF	C0 CE	LD Seg	
0FD1	CD FF	ST FF(1) @	Store Seg to display
0FD3	B8 C9	DLD Count	Decrement count
0FD5	9C DD	JNZ repeat	and repeat if not
0FD7	B8 C4	DLD cycles	zero.
0FD9	9C C9	JNZ again	repeat if not zero.
0FDB	C4 1F	LDI X'1F	Cause jump to
0FDD	30	XPAL (0)	0F20.

0000 END



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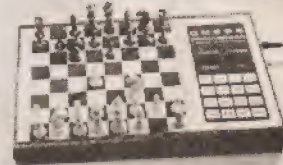
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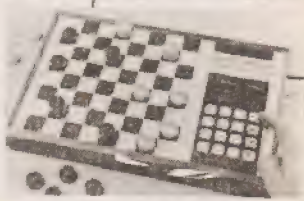
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This program is a good illustration of the flexibility of the basic NASCOM kit. The on-board PIO has been used to provide regular program interrupts which activate a priority scheduler. Up to five independent programs can be run under control of the Scheduler, with each program able to activate or de-activate other programs, or communicate via common data areas. Normally, however, each program will be run at regular intervals preset by the user.

Priority Rules OK!

Since the Scheduler is based on a priority scheme, a high priority program will suspend a lower priority program if the former becomes eligible to run before the lower priority program has finished. Consequently, higher priority programs will normally be of short execution time. There are many applications for a system of this type, for example:—

- (1) Polling of a number of devices e.g. heating control systems, burglar alarms etc., while allowing 'simultaneous' execution of applications programs.
- (2) Real-time simulation programs.
- (3) Non time-critical communication between systems.

Software Details

In the system described, the NASCOM monitor is automatically run as the lowest priority program. However, some of the monitor commands can only be used with extreme care, in particular those which either reset the stack pointer, or cause re-entry to the monitor. These include Execute, Breakpoint and Single Shot commands. It is possible to over-

come these restrictions, but since it is risky to do program testing due to the possibility of a system crash, use of the S and B commands is not recommended. The E command is not needed, since any program can be run under control of the Scheduler as described below.

Activation Of The Scheduler

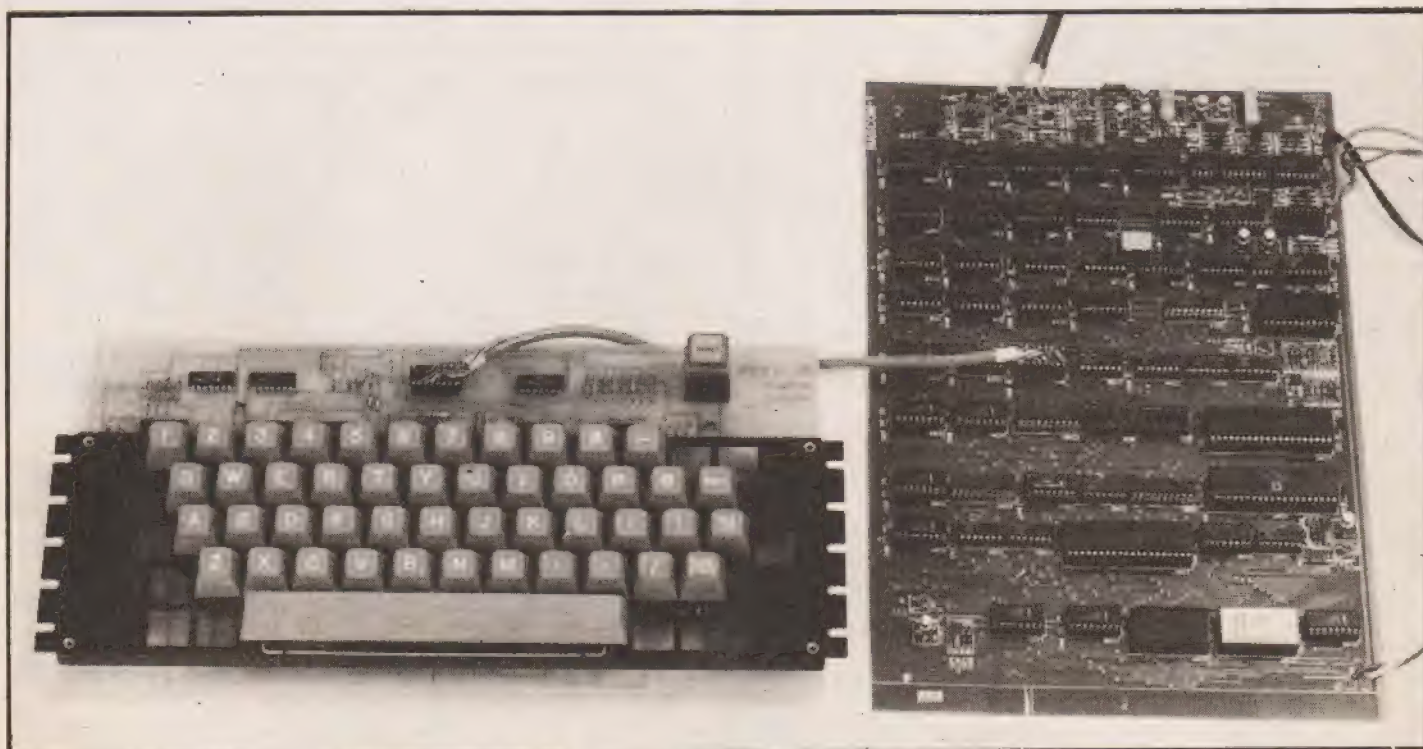
The Scheduler program should be loaded from cassette or keyboard as usual. Then, the monitor command EC90 is used to start the system. The monitor prompt should reappear immediately, showing that the monitor has been re-entered. To test the system, try the following program:—

```
> ME00
0E00 > 32 98 0A 3C 32 98 0A C9
> MC72
0C72 > 08 08 04 00 0E
>
```

This should cycle through all possible characters on the TV. If there is no response, the PIO may be in a non-reset state. This can usually be cleared by single-shotting a RETI instruction, and/or clearing the PIO internal interrupt enable (see PIO manual). When in doubt, check pin 22 of the PIO. If this is at zero volts, the PIO is hung-up waiting for a CPU response to an interrupt request. In all cases, as a last resort, the power can be switched off to clear the PIO.

Installing Programs

To run a program under the Scheduler, five control bytes must be input using the monitor M command. Byte 1 is the frequency with which the program is run, byte 2 the delay before the first activation, byte 3 is set to 4 to indicate that the program is available to run (i.e. loaded), and bytes 4 and



The Basic Nascom 1 which runs the Scheduler program.

NASCOM SCHEDULER

5 specify the entry address. Note that bytes 4 and 5 must be set up before byte 3, otherwise the program will execute from an arbitrary address. However, no problems have been experienced if all five bytes are input in one M command line.

The highest priority control bytes begin at address 0C72. Lower priorities occupy higher addresses, e.g. the next lower priority occupies location 0C77 onwards.

Hardware Details

The Scheduler expects bit 0 of PIO port A to be toggled with a TTL level clock to pin 1 of SKA. The remaining bits of port A are set up as outputs, and can be used by any program. Typical clock frequency would be in the range 30 to 60 Hz. This clock can be conveniently obtained from the on board oscillator intended to drive a printer, if the frequency is reduced by using an electrolytic across C12. The output from this oscillator is available at LINK 4 on the main board.

General Restrictions

To minimise stack space requirements, the alternate register set of the Z80 is not saved when a program is suspended. This means that only one program can use these at present. However, this is easily changed by saving and restoring these in the PIO interrupt routine.

Writing Programs For The Scheduler

The only restrictions on programs written to run under the Scheduler are that the stack pointer should not be re-assigned, and the program should terminate with a RET instruction. Care must also be taken with use of monitor routines, since these are not re-entrant.

Fig. 1. The program listing for the Scheduler.

"PRIORITY SCHEDULER

"FIRST DEFINE INTERRUPT. VECTORS

```
0C60 B2 0C          AD PIO
0C62 XX.XX         RS 14
0C70 05 00         DT 5,0
0C72 00 00 00 00 00 DT 0,0,0,0,0
0C77 00 00 00 00 00 DT 0,0,0,0,0
0C7C 00 00 00 00 00 DT 0,0,0,0,0
0C81 00 00 00 00 00 DT 0,0,0,0,0
0C86 00 00 05 00 00 DT 0,0,5,0,0
```

"NOW SET UP PIO CONTROL WORDS

```
0C8B CF 01 60 B7 FE DT CFH, 1, 60H, B7H, FEH
```

"ENTRY POINT FOR SCHEDULER

```
0C90 21 71 0C 36 88 MOV IHL, C71H & (HL), 88H
0C95 11 04 00       MOV DE, 4
0C98 2B 46          DEC HL; MOV B, (HL)
0C9A 19             LP1: ADD HL, DE
0C9B CB 8E 23       RSETB1 (HL); INC HL
0C9E 10 FA          JR, DNZ LP1
```

"ABOVE CODE INIT. TASK CONTROL LIST

"NOW ACTIVATE PIO

```
OCA0 3E 0C ED 47    MOV IA, OCH & I, A
OCA4 ED 5E          INTMODE 2
OCA6 FB            INT ON
OCA7 0E 06 2E 8B    MOV IC, 6 & L, 8BH
```

```
0CAB 06 05
0CAD ED B3
0CAF C3 86 02
```

```
0CB2 C5
```

```
0CB3 D5 E5 DD E5
```

```
0CB7 FD E5
```

```
0CB9 F5
```

```
0CBA 21 71 0C
```

```
0CBD 6E 45
```

```
0CBF CB CE
```

```
0CC1 CD 17 0D
```

```
0CC4 FB 2E 87
```

```
0CC7 35
```

```
0CC8 20 0D 2D
```

```
0CCB 7E 2C
```

```
0CCD 77 2C
```

```
0CCF CB 56
```

```
0CD1 28 03
```

```
0CD3 CB C6 45
```

```
0CD6 2D
```

```
0CD7 7D D6 05
```

```
0CDA FE 6E 6F
```

```
0CDD 20 E8
```

```
0CDF 2E 71 7E
```

```
0CE2 B8 20 0D
```

```
0CE5 70
```

```
0CE6 6E
```

```
0CE7 CB 8E
```

```
0CE9 F1 FD E1
```

```
0CEC DD E1 E1
```

```
0CEF D1 C1
```

```
0CF1 C9
```

"THIS POINT ENTERED IF A TASK"

"HAS BECOME READY FOR RUNNING

```
0CF2 38 F2          ACTA: JR, C RACTA
```

```
0CF4 70 68          ACT: MOV I(HL), B & L, B
```

```
0CF6 2C 5E          INC L; MOV E, (HL)
```

```
0CF8 2C 56          INC L; MOV D, (HL)
```

```
0CFA EB
```

```
0CFB 11 00 0D
```

```
0CFE D5 E9          SWP DE, HL
```

```
MOV DE, RSTRT
```

```
PUSH DE; JP (HL)
```

```
"JUMP TO NEW PROGRAM
```

```
0D00 21 71 0C      RSTRT: MOV HL, C71H
```

```
"REENTRY AFTER TASK
```

```
"COMPLETION
```

```
0D03 7E 6F          MOV IA, (HL) & L, A
```

```
0D05 CB 86          RSETB0 (HL)
```

```
0D07 C6 05 6F      SKIPB: ADD 5; MOV L, A
```

```
TSTB0 (HL)
```

```
0D0A CB 46          JR, Z SKIPB
```

```
0D0C 28 F9          TSTB1 (HL)
```

```
0D0E CB 4E          MOV IB, L & L, 71H
```

```
0D10 45 2E 71      JR, NZ REACT
```

```
0D13 20 D0          JR ACT
```

```
0D15 18 DD          RETIN: RETI
```

```
0D17 ED 4C          END
```

```
MOV B, 5
OUT, INCRPT
JP 286H
"JUMPS BACK TO...
"NASCOM MONITOR
```

PIO: PUSH BC

"PIO INTR. S/R

PUSH IDE&HL&IX

PUSH IY

PUSH AF

MOV HL, C71H

MOV IL, (HL) & B, L

SETB1 (HL)

CALL RETIN

INTON; MOV L, 87H

LOOP: DEC (HL)

JR, NZ SKIP; DEC L

MOV A, (HL); INC L

MOV (HL), A; INC L

TSTB2 (HL)

JR, Z SKIA

SETB0 (HL); MOV B, L

SKIA: DEC L

SKIP: MOV A, L; SUB 5

CP 6EH; MOV L, A

JR, NZ LOOP

MOV IL, 71 & A, (HL)

CP B; JR, NZ ACTA

REACT: MOV (HL), B

RACTA: MOV L, (HL)

RSTB1 (HL)

POP IAF & IY

POP IIX & HL

POP IDE & BC

RET

computing today

WHAT TO LOOK FOR
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TURING OVER A NEW LEAF

The famous English mathematician Alan Turing, apart from developing the early ACE computer at the National Physical Laboratories had previously produced a theoretical machine. Called, not surprisingly, a Turing Machine it is a mathematical model of a computer. In this article by Giles Gummer the theory of these machines is explained and a simulation program is presented for the Nascom.

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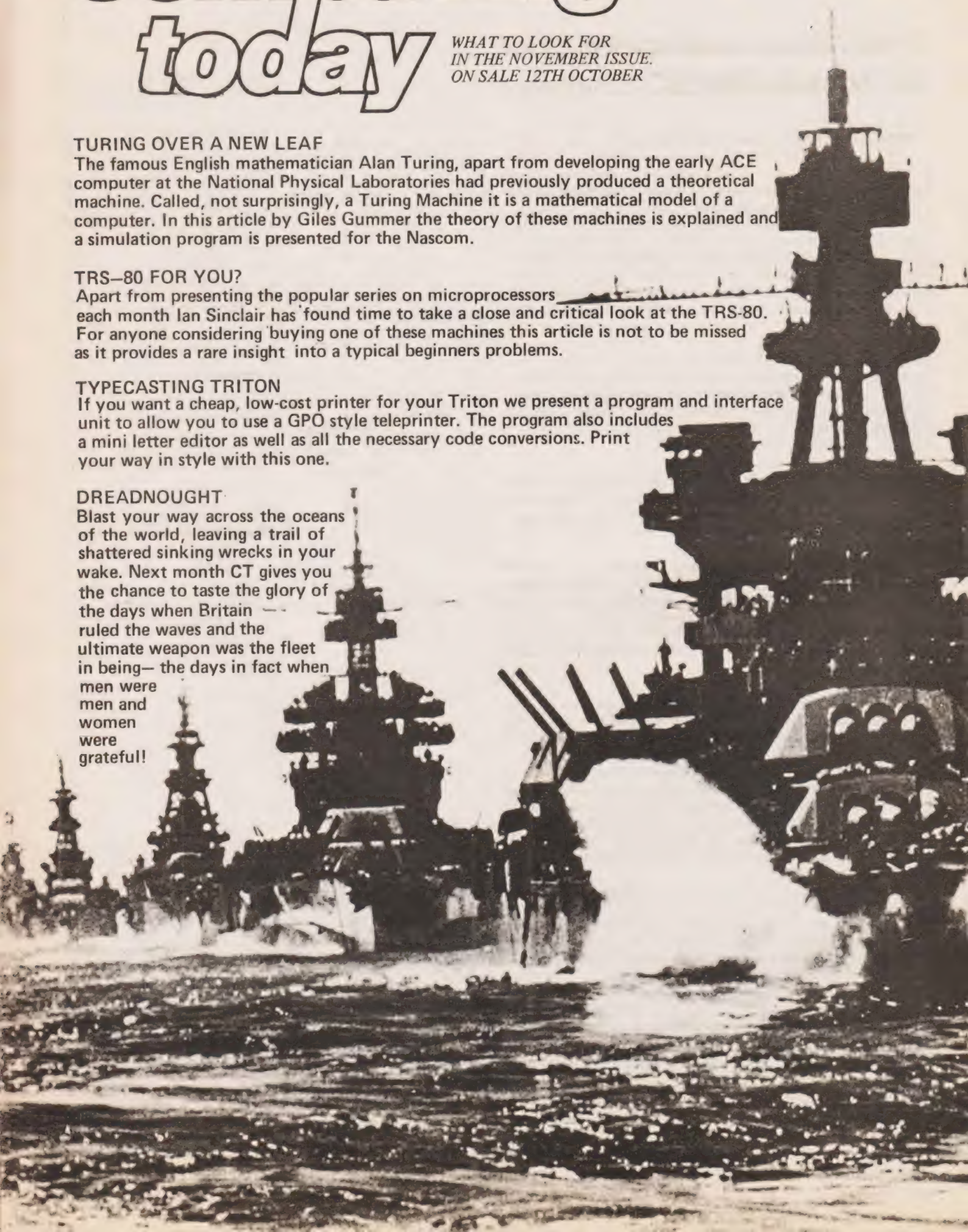
Apart from presenting the popular series on microprocessors each month Ian Sinclair has found time to take a close and critical look at the TRS-80. For anyone considering buying one of these machines this article is not to be missed as it provides a rare insight into a typical beginners problems.

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Phil Cornes continues his look at Extended BASIC Functions

The first thing to deal with this month is last month's homework, to make sure you get the hang of all the string functions and Extended BASIC generally. The first problem we set you was to convert a decimal number in the range 0–255 into 2 digits HEX.

Hexadecimal is a number system based on 16 different "digits". These range from 0–9 and for the other 6 we use letters A to F. In Hexadecimal, then, we count 00, 01, 02 0F, 10, 11 1F, 20, 21 2F, and so on up to FF. In each digit position we can put any one of 16 different symbols so that in a 2 digit Hex number there are 16×16 (ie 256) different permutations of symbols. This means that if we start from zero we can represent any integer from 0 to 255 with 2 hex digits. Conversely, any integer between 0 and 255 needs only 2 Hex digits to represent it. Before we delve into the two Hex digit conversion, let us look at a method of converting an integer 0–15 into a single Hex digit.

Handling Hex

The first point to note is that our single Hex digit can either be a number 0–9 or a letter A–F. This means that we cannot use a numeric variable to store the Hex digit (we cannot store character A–F in a numeric variable) so we will have to use a string (say A\$).

If you remember from last month we looked at the CHR\$(X) function. This function returns a single character string which has X (in decimal) as its ASCII code. If we decide to utilize this function (which we will) to convert from ASCII code to a Hex character then all that is required is to convert the input number 0–15 into the ASCII representation of its HEX equivalent.

Consider Fig. 1:—

Let A be the number 0–15 that we wish to convert. You may remember from last month that the ASCII codes for the digits 0–9 were 48–57 and the ASCII codes for letters A–F were 65–70.

This means that if the number we wish to convert is between 0–9 we should add 48 to A to give the ASCII code of the Hex digit and if A is between 10–15 we should add 55 to give an ASCII code between A–F. The resulting value of C (ASCII code) can now be converted by the CHR\$(X) function to the Hex character representation of the input value of A.

We can extend this idea to produce two Hex digits. The most significant Hex digit in a two Hex digit number is the number of 16s in the decimal number and the least significant Hex digit is the remainder. For example 250 in decimal is FA in Hex because there is 15×16 in 250 and 10 remainder. 15 in Hex is F and 10 in Hex is A.

An Easy Solution

To solve our problem therefore what we need to do is to divide the input number up into two decimal numbers between 0–15 each of which can then be converted separately into Hex digits by the subroutine of Fig. 1. This procedure is laid out in Fig. 2 (to save re-drawing it, Fig. 1 is called as a subroutine of Fig. 2). Both of these flow charts can be coded into BASIC as follows.

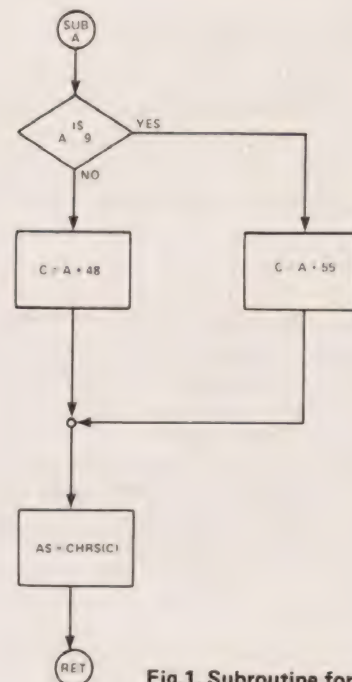


Fig.1. Subroutine for Hex conversion.

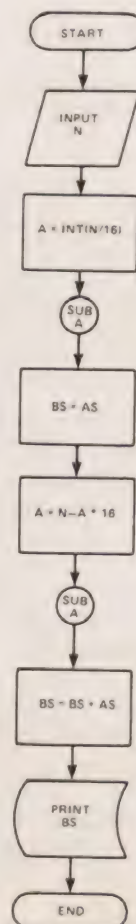


Fig.2. Complete BASIC flowchart for conversion program.


```

10 INPUT N
20 A=INT(N/16)
30 GOSUB 500
40 B$=A$
50 A=N-A*16
60 GOSUB 500
70 B$=B$+A$
80 PRINT B$
90 END
500 IF A > 9 THEN 530
510 C=A+48
520 GOTO 540
530 C=A+55
540 A$=CHR$(C)
550 RETURN
600 END

```

NOTE:— The END statement of line 90 is needed otherwise the computer will “crash” into the subroutine at line 500 straight after the printout of B\$ by line 80 even though there is no subroutine call. Thus when the computer reaches line 550 it will execute a return statement and find that there is no return address stored and “bomb out”.

Similar principles to those given above using the ASC(STRING) function can be applied to the second question of the homework. The flow charts of Figs. 3 and 4 and the program below are given as a possible solution without explanation. It is left to you to sort out how they work (good practice).

```

10 INPUT A$
20 B$=LEFT$(A$,1)
30 GOSUB 500
40 N=A*16
50 B$=RIGHT$(A$,1)
60 GOSUB 500
70 T=T+A
80 PRINT T
90 END
500 C=ASC(B$)
510 IF C > 57 THEN 540
520 A=C-48
530 GOTO 550
540 A=C-55
550 RETURN
600 END

```

Right! Having demonstrated some of Extended BASIC's facilities we will now go on to look at the third thing we mentioned last month for homework — sorting. Approximately 95% of all computer time used anywhere is used by commercial concerns in the process of running a business. Very little computer time is used for scientific applications. Of this vast amount of computer time used commercially, about one third is spent sorting and searching through lists of data items so that useful information may be extracted. It is to these two areas, sorting and searching that our attention now turns and this month we will look at a simple search and at how to merge two sorted lists together.

Simple Search

Imagine a list of names, addresses and telephone numbers. If we are given a name we can look through the list for this name and when we find it we can look up the corresponding address and telephone number. This process is called searching and the item we are using to find the required infor-

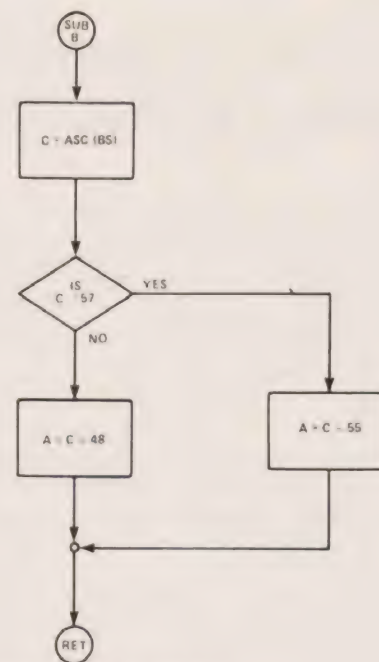


Fig.3. Subroutine for Hex to Decimal conversion.

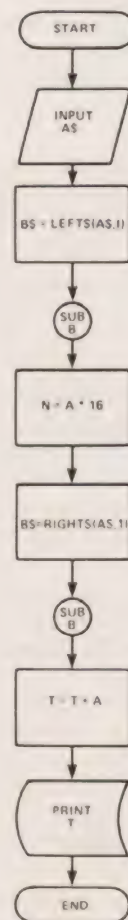


Fig.4. Complete BASIC flowchart for reverse conversion.

mation is called the key. Here we are using the name to find the address and telephone number so the name is the key. If the items in the list are in random order, then there is really

BEGINNING BASIC

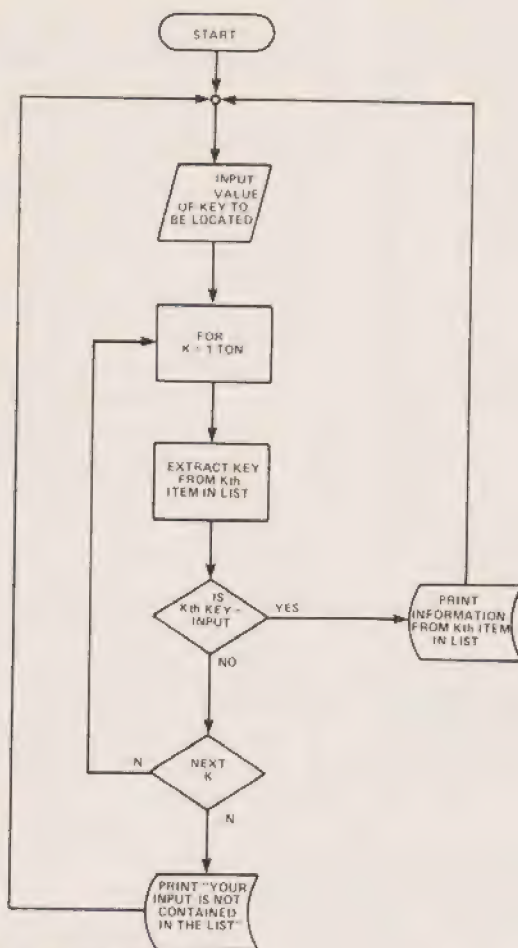


Fig.5. Search routine flowchart.

only one way of finding any given item; that is to look through the list from the beginning, one item at a time, until the required item is located.

So the flowchart of an algorithm to perform this simple searching technique might be as Fig. 5. The following notes might help you to understand Fig. 5 better. N is the number of items in the list and K is the number of the item that we are currently looking at. The list itself might well be contained in a string array, eg A\$(0) to A\$(9) is a list of ten elements each of which would be capable of storing 256 characters.

Working through Fig. 5 the first box asks that we input the key that we are to search for (eg input the name whose address and telephone number we seek). We then set up a FOR NEXT loop from 1 to the number of items in the list. The third box extracts the key from the Kth item of the list. This is necessary because it is quite possible that the search key might not be at the beginning of each item. For example, if our list were in telephone number order with telephone numbers specified first, then address specified second, and lastly name, we would need to extract the last so many characters to compare them with our input. This comparison is carried out in the 4th flowchart box. If it turns out that the extracted key from the Kth item on the list is the same as the input then the information (address and telephone number) is printed out. If the two items are not the same, K is incremented by one and the key is extracted from the next item in the list to be checked. This process is continued until the extracted key matches the input or until the computer has checked through all the items on the

list and not found a match in which case a message to this effect is printed.

Two List Merging

Imagine two lists of numbers that have already been sorted out into numerical order and imagine further that these two lists have been assigned to two array variables, eg

X	A(X)	B(X)
1	1	-1
2	3	2
3	12	13
4	24	15

It is required that the two lists A(X) and B(X) be merged together to produce a single list containing 8 items and that the merged list say C(X) should also be in ascending numerical order.

The method of solution for this problem is to compare the first item in array A with the first item in array B. The least of these should be made the first item of array C. In this case B(1) is less than A(1) so C(1) will be set equal to B(1) (ie -1). We will now compare A(1) with B(2), the least of these will become C(2). Here A(1) < B(2) so C(2)=A(1)=1 and we then compare A(2) with B(2) and put the least of these into C(3) etc. A program to perform this algorithm is given below without any further explanation so that you can dry run it yourselves.

```

10 DIM A(4),B(4),C(8)
15 FOR X=1 TO 4
20 INPUT A(X),B(X)
25 NEXT X
30 A=1
35 B=1
40 C=1
50 IF A(A) > B(B) THEN 90
60 C(C)=A(A)
70 A=A+1
80 GOTO 110
90 C(C)=B(B)
100 B=B+1
110 C=C+1
120 IF A=5 THEN 150
130 IF B=5 THEN 190
140 GOTO 50
150 FOR D=B TO 4
160 C(D+4)=B(D)
170 NEXT D
180 GOTO 220
190 FOR D=A TO 4
200 C(D+4)=A(D)
210 NEXT D
220 FOR C=1 TO 8
230 PRINT C(C)
240 NEXT C
250 END
    
```

Try It Yourself

The homework for this month is to work out what lines 120-210 of the two list merge program above are included for and when you have worked it out try to think of another way of doing this which although not as general will reduce the length of the program listing considerably.

Next month we will go on to look at a more involved search algorithm and a simple sort routine.

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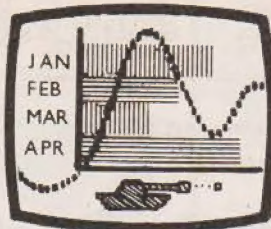
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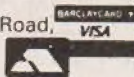
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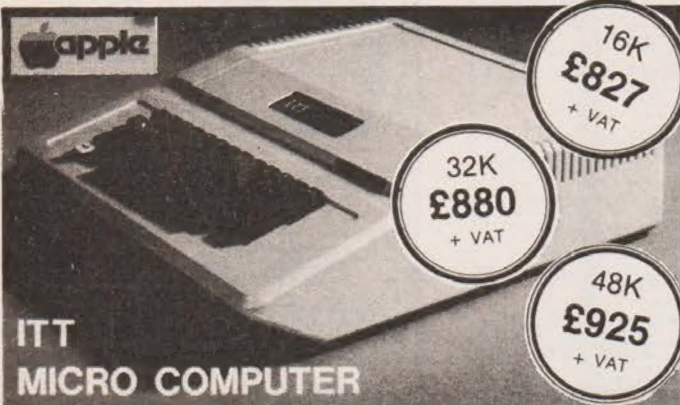
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Erases last character typed.
CR Carriage Return — must be at the end of each line.
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CONT LIST	NEW	NULL	RUN		
STATEMENTS					
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GOTO GOSUB	IF GOTO	IF THEN	INPUT	LET	
NEXT ON GOTO	ON GOSUB	POKE	PRINT	READ	
REM RESTORE	RETURN	STOP			

EXPRESSIONS

OPERATORS

+, -, *, /, NOT, AND, OR, >, <, <=, >=, RANGE 10⁻³² to 10⁺³²

VARIABLES

A, B, C, ... Z and two letter variables
The above can all be subscripted when used in an array. String variables use above names plus \$ e.g. A\$.
String variables use above names plus \$ e.g. A\$.

FUNCTIONS

ABS(X)	ATN(X)	COS(X)	EXP(X)
LOG(X)	PEEK(I)	POS(I)	RND(X)
SPC(I)	SQR(X)	TAB(I)	TAN(X)
FRE(X)	INT(X)		
SGN(X)	SIN(X)		
USR(I)			

STRING FUNCTIONS

ASC(X\$)	CHR\$(I)	FRE(X\$)	LEFT\$(X\$, I)
RIGHT\$(X\$, I)		STR\$(X)	
LEN(X\$)	MID\$(X\$, I, J)		
VAL(X\$)			

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 - 3) Entries must be received by midnight on 29/2/80, any received after this time are void.
- Winners will be notified by post before 31/3/80.
- 4) You warrant by your signature that all programs and documentation material included is entirely your own creation, and that no rights to it have been given or sold to any other party, and you agree to allow **COMPUKIT LTD.** to use, publish, distribute, modify, and edit it as it sees fit.

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